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Attachments	Total Number of Pages
Attachment I - Sketch of Surface Layout	6
Attachment II - Description of Analysis Methods	20
Attachment III - Identification of Seismically-Initiated Potential Events	138
Attachment IV -Structures, Systems, and Components Important to Safety with DBGM Assignments	42
Attachment V - Generalized Seismic Event Trees	10
Attachment VI - Fault Trees	8
Attachment VII - Source Data for Ground Motions Associated with Reference Earthquakes	6
Subtotal	= 230 pages

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. QER (Print/Sign/Date)	16. Approved/Accepted (Print/Sign)	17. Date
00A	Initial issue							
00B	Complete revision to address revised design and source references. This information includes updated System Description Document and Facility Description Document information concerning design and operations of the repository facilities and systems. The updated information is used extensively throughout this revision. This revision supersedes Rev 00A.	340 (110 +230)	VII-6	Ernest N. Lindner SIGNATURE ON FILE 11/30/04	Douglas D. Orvis SIGNATURE ON FILE 11-30-04	Joe L. Lacret SIGNATURE ON FILE 12/2/2004	Dennis C. Richardson SIGNATURE ON FILE 12/3/2004	~~11/30/04~~ 12/3/2004

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TABLES

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ACRONYMS AND ABBREVIATIONS

BDBGM	beyond-design basis ground motion
BWR	boiling-water reactor
CDFM	conservative deterministic failure margin
CHF	Canister Handling Facility
CSNF	commercial spent nuclear fuel
CSNFA	commercial spent nuclear fuel assembly
DBGM	design basis ground motion, with levels designated as DBGM-1 and DBGM-2
DOE	U.S. Department of Energy
DPC	dual-purpose canister
DSNF	DOE-owned spent nuclear fuel
DTF	Dry Transfer Facility, with separate buildings abbreviated as DTF-1 and DTF-2
FHF	Fuel Handling Facility (Also known as: Bare Fuel Handling Facility)
HAM	horizontal aging module
HCLPF	high confidence of low probability of failure
HEPA	high-efficiency, particulate air (filter)
HFE	human failure event
HLW	high-level radioactive waste
HVAC	heating, ventilation, and air conditioning
ITS	important to safety
LLW	low-level (radioactive) waste
LOSP	loss of offsite power
MAPE	mean annual probability of exceedance
MCO	multi-canister overpack
MGR	monitored geologic repository
MLD	master logic diagram
MSC	monitored geologic repository site-specific cask
MTHM	metric tons of heavy metal
NPP	nuclear power plant
NRC	U.S. Nuclear Regulatory Commission
NSNF	naval spent nuclear fuel
PGA	peak ground acceleration, computed as spectral acceleration at 100 Hz
PCSA	preclosure safety analysis
PWR	pressurized water reactor

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RC	rack collapse
$S_{A(1-2.5)}$	average of the horizontal spectral accelerations at 1 Hz and 2.5 Hz
$S_{A(5-10)}$	average of the horizontal spectral accelerations at 5 Hz and 10 Hz
SET	seismic event tree
SMA	seismic margins analysis
SNF	spent nuclear fuel
SRTC	site rail transfer cart
SSC	structure, system, or component
SSCs	structures, systems, and components
SSE	Safe Shutdown Earthquake
TEDE	total effective dose equivalent
WP	waste package

MATHEMATICAL NOMENCLATURE AND UNITS OF MEASURE

[AND]	logical intersection (AND) operator
β_C	composite strength variability
$C_{0.01}$	seismic capacity for which probability of failure is 0.01
C_{CDFM}	seismic capacity by conservative deterministic failure margin method
$C_{98\%}$	98 percent exceedance probability capacity
C_C	computed capacity
D_{NS}	expected concurrent nonseismic demand
D_S	seismic demand
F_C	capacity increase factor
F_{HCLPF}	HCLPF multiplier factor, equal to sum of F_S and F_μ
$F_{HCLPF_{99\%}}$	F_{HCLPF} factor at 99 percent exceedance capacity
$F_{HCLPF_{50\%}}$	F_{HCLPF} factor at median capacity
F_μ	inelastic energy absorption factor
F_S	strength margin factor
$F_{S_{98\%}}$	98 percent exceedance capacity strength margin factor
$F_{S_{50\%}}$	50 percent exceedance (median) capacity strength margin factor
ft	feet
g	acceleration due to gravity at sea level (32 ft/sec^2 or 9.8 m/sec^2)
Hz	hertz (cycles per second)
in	inch
kV	kilovolt (10^{+3} volt)
max{•}	maximum operator
min{•}	minimum operator
m	meter
mm	millimeter (10^{-3} m)
mrem	millirem (10^{-3} rem)
mSv	millisievert (10^{-3} Sv)
[OR]	logical union (OR) operator
rem	roentgen equivalent man, unit of quantities expressed as dose equivalent.
SI	International System of Units (Système International d'Unités)
Sv	Sievert is the SI unit of the quantities expressed as dose equivalent (rem)

1. PURPOSE

The purpose of this seismic preclosure safety analysis is to identify the potential seismically-initiated event sequences associated with preclosure operations of the repository at Yucca Mountain and assign appropriate design bases to provide assurance of achieving the performance objectives specified in the Code of Federal Regulations (CFR) 10 CFR Part 63 for radiological consequences. This seismic preclosure safety analysis is performed in support of the License Application for the Yucca Mountain Project.

In more detail, this analysis identifies the systems, structures, and components (SSCs) that are subject to seismic design bases. This analysis assigns one of two design basis ground motion (DBGM) levels, DBGM-1 or DBGM-2, to SSCs important to safety (ITS) that are credited in the prevention or mitigation of seismically-initiated event sequences. An application of seismic margins approach is also demonstrated for SSCs assigned to DBGM-2 by showing a high confidence of a low probability of failure at a higher ground acceleration value, termed a beyond-design basis ground motion (BDBGM) level.

The objective of this analysis is to meet the performance requirements of 10 CFR 63.111(a) and 10 CFR 63.111(b) for offsite and worker doses. The results of this calculation are used as inputs to the following:

- A classification analysis of SSCs ITS by identifying potential seismically-initiated failures (loss of safety function) that could lead to undesired consequences
- An assignment of either DBGM-1 or DBGM-2 to each SSC ITS credited in the prevention or mitigation of a seismically-initiated event sequence
- A nuclear safety design basis report that will state the seismic design requirements that are credited in this analysis.

The present analysis reflects the design information available as of October 2004 and is considered preliminary. The evolving design of the repository will be re-evaluated periodically to ensure that seismic hazards are properly evaluated and identified. This document supersedes the seismic classifications, assignments, and computations in *Seismic Analysis for Preclosure Safety* (BSC 2004a).

2. QUALITY ASSURANCE

The Office of Civilian Radioactive Waste Management, Quality Assurance Program, applies to this design analysis because it relates to items important to public radiological safety. The analysis was prepared in accordance with AP-3.12Q, *Design Calculations and Analyses*, and AP-3.15Q, *Managing Technical Product Inputs*.

3. USE OF SOFTWARE

3.1 SOFTWARE TRACKED BY CONFIGURATION MANAGEMENT

None used.

3.2 COMMERCIAL OFF-THE-SHELF SOFTWARE USED

Commercial off-the-shelf software is used in this calculation. Microsoft® Word™ (version: Word 97) is used for standard word processing and Microsoft® Excel™ (version: Excel 97) is used to tabulate information and perform simple calculations involving products and sums. Microsoft® Visio™ (version: Professional 2002) was used to produce fault trees and logic diagrams. The computations and software do not require qualification under LP-SI.11Q-BSC, *Software Management*.

4. INPUTS AND ANALYSIS BASIS

4.1 DIRECT INPUTS

4.1.1 Waste Forms

Spent nuclear fuel (SNF) and high-level radioactive waste (HLW) will arrive at the repository in solid form in a variety of types and sizes. These waste forms will include (BSC 2004b, pp. 4-1 to 4-14; BSC 2004c, pp. 4-1 to 4-7; and DOE 2002a, pp. 10 to 17):

- Commercial spent nuclear fuel (CSNF) assemblies
- Dual-purpose canisters (DPC) containing CSNF
- DOE-owned spent nuclear fuel (DSNF) canisters
- Naval spent nuclear fuel (NSNF) canisters
- DOE HLW canisters.

CSNF is further divided between waste from boiling-water reactors (BWR) and pressurized water reactors (PWR).

4.1.2 Reference Design for Surface Facilities

Facility names will follow the sketch of the surface facilities, as shown in Attachment I, modified from BSC (2004d).

The reference design for the repository includes several systems and facilities handling HLW:

- Railcar Staging Area and Truck Staging Area, defined together in this analysis as the Transportation Facility (part of the Balance of Plant [BSC 2004e])

- Receipt Systems, including Transportation Cask Receipt/Return Facility (TCRRF) and Transportation Cask Buffer Area (BSC 2004f)

- Canister Handling Facility (CHF) (BSC 2004g)
- Dry Transfer Facility (DTF) (BSC 2004h) (two units, each containing a Remediation System [BSC 2004i])
- Fuel Handling Facility (FHF) (BSC 2004j)
- SNF Aging Facility (BSC 2004k)
- Subsurface Facility (BSC 2004l).

Information is also taken from facility and system description documents and other references (including BSC 2004m; BSC 2004n; BSC 2004o) together with descriptions in BSC (2004p, Section 6.6). A Shielded Canister Transfer System (SCT) Facility (Arthur 2003) is not included as this facility has not been sufficiently defined.

Significant details include:

- The emplacement drifts are loaded with approximately 11,200 waste packages (WPs) (Williams 2003a, Table 3).
- DTF staging racks accommodate 120 CSNF assemblies (72 BWR and 48 PWR) and 10 canisters (BSC 2004h, Section 4.1.4.1, Staging).
- The staging racks in the wet remediation area accommodate, at a minimum, 48 PWR CSNF assemblies, 72 BWR CSNF assemblies, and 10 DOE waste canisters (BSC 2003a, Asset WBS 1.5.04.01.02; BSC 2004i, Section 3.1.2.2.3).
- The initial SNF Aging Facility will contain 1,000 MTHM (BSC 2004k, Section 4.1.1.1), which represents about 2,500 CSNF assemblies (CSNFAs). Four additional pads (5,000 MTHM each), located to the northwest of the process buildings, may be added to accommodate an additional 20,000 MTHM. There is also provision on the site layout plan to accommodate an additional 19,000 MTHM as a contingency (BSC 2004k, Section 4.1.1.1).
- The initial SNF Aging Facility will have 80 vertical storage positions and 20 horizontal positions as part of a single module (slab unit); subsequent facilities will contain five such modules (BSC 2004k, Section 4.1.1.1 and Figure B-4).
- The CHF will have a shielded staging pit for 10 DSNF/HLW canisters (BSC 2004g, Section 4.1.1).
- The FHF will have one closure cell (BSC 2004j, Section B.2.1.3) and will not receive DSNF multi-canister overpacks, horizontal dual-purpose canisters, and non-standard fuel (BSC 2004j, Section 1.1).

4.1.3 Applicable Seismic Events

Monitored Geologic Repository External Events Hazards Screening Analysis (BSC 2004q, Section 7 and Table 2) concludes that seismic events are applicable to the repository. Design for vibratory ground motion is based on the potential occurrence of natural seismic activity or man-induced events, such as weapons testing on the Nevada Test Site (Section 4.1.11).

4.1.4 Design and Operation of Repository

The design and operation of the repository and potential internal events are described and identified in *Internal Hazards Analysis for License Application* (BSC 2004p), based on existing designs together with cited supplemental information and assumptions in Section 5. Most details of the repository waste handling operation in this analysis are taken from BSC (2004p, Section 6.6).

4.1.5 SSCs Important to Safety

The list of SSCs that are classified as ITS are identified in *Q-List* (BSC 2004r, Appendix A). Event sequences are categorized and descriptions of design features that are credited with prevention or credited for mitigation of the radiological consequences of such event sequences are identified in *Categorization of Event Sequences for License Application* (BSC 2004s).

4.1.6 Offsite Dose Information for Unmitigated Release of Radioactivity

Preclosure Consequence Analyses for License Application (BSC 2004t, Table 23) provides offsite dose information for unmitigated release of radioactivity from CSNFAs. Unfiltered offsite doses from NSNF and vitrified HLW canisters are provided in BSC (2004t, Table 24).

4.1.7 Definitions and Mean Annual Probability of Exceedance for DBGM Levels

The definition and mean annual probability of exceedance (MAPE) of the reference design earthquakes are obtained from *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain* (BSC 2004u, Section 3.1.1). Two DBGM levels for design are defined and used in these analyses: DBGM-1 at 1×10^{-3} MAPE and DBGM-2 at 5×10^{-4} MAPE.

4.1.8 Definition of Beyond Design Basis Ground Motion Level for Demonstration of Capacity for DBGM-2 Structures, Systems, and Components

For SSCs designed to a DBGM-2 level, structural analyses will be conducted at a beyond design basis ground motion (BDBGM) level to demonstrate the capacity of the SSCs to perform their intended safety functions at ground motion levels that are greater than the design basis. SSCs designed to DBGM-2 level will be evaluated for a BDBGM at the 1×10^{-4} MAPE (BSC 2004u, Section 3.3.1).

4.1.9 Estimates of Peak Ground Acceleration and Spectral Acceleration for Reference Earthquakes

The horizontal peak ground acceleration (PGA) is commonly used as the primary parameter in seismic analyses and design, as well as to describe structural fragilities (e.g., Budnitz et al. 1985; McGuire et al. 2002; Chen et al. 1991, Section 3.1.1.2). PGA will be utilized for the present seismic margins analysis (SMA) approach as the hazard parameter, and is defined in this context as the maximum horizontal spectral acceleration at 100 Hz.

In addition, for many cases of interest, spectral accelerations in the range of 1 to 2.5 Hz and 5 to 10 Hz can be of primary importance in structural response and either can be used as a design parameter (e.g., Regulatory Guide 1.165, Appendix C). Thus, seismic ground motion parameters of the average horizontal spectral accelerations at 1 to 2.5 Hz [$S_{A(1\text{-}2.5)}$] and 5 to 10 Hz [$S_{A(5\text{-}10)}$] are included here for reference.

The parameter values and source data sets are presented in Table 1. Estimates of the PGA and average spectral accelerations for the reference earthquakes are based on information from seismic data sets (indicated by document tracking numbers [DTNs]).

4.1.10 Preclosure Radiation Dose Limits

Relevant preclosure dose limits for Category 1 and Category 2 event sequences are presented in Table 2, based on applicable regulations. The dose values shown are for total effective dose equivalent (TEDE), a measure of body dose. Other higher limits for other parts of the body are specified per 10 CFR 63.111(b)(2), 10 CFR 20.1201 to 1204, 10 CFR 20.1207 to 1208, and 10 CFR 20.1301 to 1302. Dose limits for Category 1 event sequences for the present analysis are taken as the maximum annual dose.

4.1.11 Probability of Category 1 and Category 2 Sequences

Category 1 sequences are defined as "those event sequences that are expected to occur one or more times before permanent closure of the geologic repository operations area" (10 CFR 63.2). For a 100-year preclosure duration (Assumption 5.12) and a chance of occurrence of once, this can be stated as at least 1 chance over 100 years, or an annual probability of occurrence of 10^{-2}.

Category 2 sequences are defined as "event sequences that have at least one chance in 10,000 of occurring before permanent closure" (10 CFR 63.2). Again, for a 100-year preclosure duration (Assumption 5.12), this can be stated as at least 1 chance in 1,000,000 per year, or an annual probability of occurrence of 10^{-6}.

Table 1. Ground Motions Associated with Reference Earthquakes

Part A: Peak Ground Accelerations

Ground Motion Category	Mean Annual Probability of Exceedance (MAPE)	Horizontal Peak Ground Acceleration (PGA) (g)		DTN
		Surface [a,b]	Subsurface	
DBGM-1	1.0×10^{-3}	0.37	0.13	MO0411SDSDE103.003, MO0405SDSTPNTB.001
DBGM-2	5.0×10^{-4}	0.58	0.19	MO0411SDSTMHIS.006, MO0407SDARS104.001
BDBGM	1.0×10^{-4}	1.19	0.43	MO0411WHBDE104.003, MO0306SDSAVDTH.000

Part B: Spectral Accelerations

Ground Motion Category	Mean Annual Probability of Exceedance (MAPE)	Average Horizontal Spectral Accelerations [c] (g)			DTN
		Range	Surface [a,b]	Subsurface	
DBGM-1	1.0×10^{-3}	$S_{A(1\text{-}2.5)}$	0.43	0.17	MO0411SDSDE103.003, MO0405SDSTPNTB.001
		$S_{A(5\text{-}10)}$	0.80	0.25	
DBGM-2	5.0×10^{-4}	$S_{A(1\text{-}2.5)}$	0.67	0.24	MO0411SDSTMHIS.006, MO0407SDARS104.001
		$S_{A(5\text{-}10)}$	1.22	0.37	
BDBGM	1.0×10^{-4}	$S_{A(1\text{-}2.5)}$	1.58	0.55	MO0411WHBDE104.003, MO0306SDSAVDTH.000
		$S_{A(5\text{-}10)}$	2.52	0.83	

NOTES: [a] Surface values were defined for the "Waste Handling Building Area" (BSC 2002, Figure 1) based on profiles for 35 ft (11 m) and 110 ft (34 m) of alluvium (soil).

[b] PGA values for surface facilities are computed at Point D/E at 5% damping. Location of computation points for surface facilities and emplacement level is shown in BSC (2004v, Figure 1). PGA values are calculated at a frequency of 100 Hz (period = 0.01 second).

[c] $S_{A(1\text{-}2.5)} = [(SA_1 + SA_{2.5}) / 2]$ and $S_{A(5\text{-}10)} = [(SA_5 + SA_{10}) / 2]$, where SA_1, $SA_{2.5}$, SA_5, and SA_{10} are the maximum horizontal spectral accelerations at 1 Hz, 2.5 Hz, 5 Hz, and 10 Hz, respectively, for 5% damping.

Source data and file names for above values are shown in Attachment VII.

BDBGM = beyond design basis ground motion; DBGM = design basis ground motion; DTN = document tracking number; g = acceleration due to gravity; SA = spectral acceleration; $S_{A(X\text{-}Y)}$ = average spectral acceleration for a range, computed as the average of spectral accelerations at frequency "X" and frequency "Y".

Table 2. Bases for Assigning Design Basis Ground Motions to SSCs ITS

Performance Objectives Applied to Seismic Preclosure Safety	Dose Receptor	Consequences of Loss of SSC Safety Function Single Sequence Dose Limit (TEDE) [a]	DBGM Assigned to SSCs ITS [c]
Category 1 Event Sequences [10 CFR 63.111(b)(1), 10 CFR 20.1201-1204, 10 CFR 20.1207-1208, 10 CFR 20.1301-1302]	Radiation Worker	>5 rem (0.05 Sv)	DBGM-1
	Controlled Area Worker Beyond Geologic Repository Operations Area Or Member of Public on Site and Beyond Geologic Repository Operations Area Or NTS/Nellis Workers in Unrestricted Area	>100 mrem (1.0 mSv) [d] or >2 mrem (0.02 mSv) per hour [d] or >10 mrem (0.1 mSv) from air emissions [d]	DBGM-1
	Member of Public Beyond Site Boundary, in General Environment	>15 mrem (0.15 mSv)	DBGM-1
Category 2 Event Sequences [10 CFR 63.111(b)(2)]	Individual at or Beyond the Site Boundary [b]	>5 rem (0.05 Sv)	DBGM-2
Criticality Condition [10 CFR 63.112(e)(6)]	N/A	N/A	DBGM-2

NOTES: [a] Values are for TEDE (a measure of body dose). Higher dose equivalents for the lens of the eye, skin, and extremities are not included in the table, but are subject to separate limits per 10 CFR 63.111(b)(2), 10 CFR 20.1101, 10 CFR 20.1201 to 1204, 10 CFR 20.1207 to 1208, and 10 CFR 20.1301 to 1302.

[b] At any point on the site boundary.

[c] Any seismic event sequence that results in a breach of a DSNF canister is assumed to exceed 5 rem TEDE at the site boundary for the purposes of assigning DBGM-2. Doses from such canister breaches will not be explicitly calculated.

[d] Limit doses do not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under 10 CFR 35.75, or from voluntary participation in medical research programs.

DBGM = design basis ground motion; ITS = important to safety; NTS = Nevada Test Site; SSCs = structures, systems, and components; TEDE = total effective dose equivalent.

4.2 DESIGN BASES FOR CASK/WASTE PACKAGE/CANISTER DROPS

4.2.1 Drop Characteristics of Transportation Casks

Requirements for transportation casks are defined in 10 CFR Part 71. Transportation casks with impact limiters are required to withstand (without breach) a 30 ft (9 m) drop onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected (10 CFR 71.73). The cask is also to withstand (without breach) a drop from 40 in (1 m) onto a vertical steel bar 6 in (0.15 m) in diameter, and normal vibrations incident to transport (10 CFR 71.71).

In addition, material within transportation casks must be subcritical even with the most reactive credible configuration of the fissile material and moderation to the most reactive credible extent (10 CFR 71.55).

4.2.2 Drop Characteristics of U.S. Department of Energy Canisters

There are several kinds of DOE canisters. For spent nuclear fuel, there are standardized canisters and multi-canister overpacks (MCOs). The term, "DSNF canister," includes standardized and MCO canisters. The following criteria are used for guidance:

- DSNF standardized canisters can withstand, without breaching, a drop in any orientation from a height of 23 ft (7.0 m) onto an essentially unyielding surface (BSC 2004w, Section 6; DOE 2002b, Section 4.3.7).

- MCO canisters can withstand, without breaching, a flat bottom drop (3 degrees or less from vertical) from a height of 23 ft (7.0 m) and a drop in any orientation from a height of 2 ft (0.6 m) (individually - not both in sequence) onto an essentially unyielding surface (BSC 2004w, Section 6).

- The probability that a DSNF canister is defective such that it may breach if dropped from within the height limits stated above is 2.3×10^{-4} (BSC 2004w, Section 6).

- The DOE HLW canisters can withstand, without breaching, a drop to less than 23 ft (7.0 m) above the bottom of cask, waste package, staging rack, or staging pit (based on analysis and testing) (BSC 2001, Section 6.1).

4.2.3 Drop Characteristics of Waste Package

Design requirements will ensure that the waste package will withstand without breaching the following drop and tipover events (BSC 2004s, Assumption 5.1.3.12). The following criteria are used for guidance:

- Free drop (with trunnion collars installed) on a flat unyielding surface, starting from a horizontal position located 7.9 ft (2.4 m) above an essentially unyielding surface

- Free drop (with trunnion collars installed) on a flat unyielding surface, starting from a vertical position located 6.6 ft (2.0 m) above an essentially unyielding surface

- Free drop with emplacement pallet (without trunnion collars) from a position located 6.6 ft (2.0 m) above an essentially unyielding surface

- Tipover and slap down (with trunnion collars installed) from a vertical position onto an essentially unyielding horizontal surface.

4.2.4 Drop of Naval Spent Nuclear Fuel Canisters

NSNF canisters are to be designed to preclude a dose greater than that prescribed for the limit of a Category 2 sequence [i.e., the more limiting of a TEDE of 0.05 Sv (5 rem), or the sum of the deep dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv (50 rem). The lens dose equivalent may not exceed 0.15 Sv (15 rem), and the shallow dose equivalent to skin may not exceed 0.5 Sv (50 rem)] after sustaining a flat bottom drop or a drop in any orientation (DOE 2002b, Section 4.4.8).

4.3 DEFINITION OF SAFETY FUNCTIONS

4.3.1 General

Each SSC ITS that is credited in the prevention or mitigation of a seismically-initiated event sequence will be assigned a safety function (or functions) with regard to performance goals for the specific SSC during and after the initiating seismic event. This section defines the safety functions employed for this analysis; the functions are defined based on prior analyses and engineering judgement.

4.3.2 Safety Function: No Structural Collapse

The safety function, “no structural collapse,” is assigned to facilities and structures assigned to either a DBGM-1 or DBGM-2 level. For seismic margin calculations, the function corresponds approximately to the state of “large permanent distortion, short of collapse” of a structure or facility, termed Limit State A by BSC (2004u, Table A-1). [Note that for design, structural analyses will be performed to demonstrate compliance with a more-restrictive Limit State C, or limited permanent distortion, essentially requiring minimal damage to the structure.]

The no structural collapse safety function has the following performance goals during and after a seismic event:

- No structural collapse occurs (i.e., column and support members remain upright, beams remain functional, and walls remain standing), and failure of contents is not serious enough to cause severe injury or death, prevent evacuation, or induce a breach of a waste container.

- Confinement of internal airflow is not required and may not be maintained. Concrete walls will remain standing, but may be extensively cracked; they may not maintain pressure differential with normal heating, ventilation, and air conditioning (HVAC). Cracks will still provide a tortuous path for material release. The largest cracks are expected to be no greater than ½ in (12 mm).

- Distortion of the structure will be limited, but expected to be visible to the naked eye.
- Components will remain anchored, but with no assurance that they will remain functional or easily repairable.

These goals are modified from various facility requirements for seismic design (DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Appendix C). However, no direct correlation is adopted between this safety function and any defined performance category in DOE-STD-1020.

An additional requirement of this safety function is that the failure of adjacent structures and other SSCs (whether safety-related or not) shall be considered in seismic analyses, as appropriate, and shall not induce collapse of the designated structure.

4.3.3 Safety Function: No Drop

The safety function, "no drop," is assigned to cranes assigned to a DBGM-2 level. The no-drop safety function has the following performance goals during and after a seismic event:

- The crane shall not release (or drop) a waste container or waste form either due to failure of crane components or controls due to a designated seismic event.
- The crane, as a system, shall not collapse or fall down. The crane shall remain on its track or guide system (regardless if crane is holding a waste container or waste form at the time of the event).
- Horizontal movement (swinging) of the waste cask or waste package shall be restrained (if necessary) to preclude impacts with nearby walls and barriers.
- The crane track or guide system shall remain intact and attached to the structure. It may be distorted and bent, however.
- The crane shall not move in an uncontrolled manner or exceed its design speed limit.

4.3.4 Safety Function: No Breach

The safety function, "no breach," is assigned to various waste containers assigned to either a DBGM-1 or DBGM-2 level.

The no breach (leak tight) safety function has the following performance goal during and after a seismic event:

- Containment of the waste form is maintained and no release or dispersement of radionuclides (either as gas or particulates) to the environment occurs.

- Distortion and damage of the container will be limited.

4.3.5 Safety Function: No Tipover

The safety function, "no tipover," is assigned to various SSCs handling casks and canisters (e.g., turntables and pedestals) assigned to either a DBGM-1 or DBGM-2 level. The no tipover safety function has the following performance goal during and after a seismic event:

- The SSC shall not allow a tipover of a cask or canister (i.e., an overturn from an upright or normal position and impact the floor, ground, or other object), or tilting of the cask or canister resulting in an impact with an adjacent SCC ITS causing a domino effect.

4.3.6 Safety Function: No Slap Down

The safety function, "no slap down," is assigned to various SSCs handling casks and canisters (trolleys, waste package transporters, transport locomotives, HAMs, MSC transporters) assigned to either a DBGM-1 or DBGM-2 level. The no slap down safety function has the following performance goals during and after a seismic event:

- The SSC shall not allow a slap down or rapid drop of a waste cask or waste package in transit (i.e., the fall of a package or canister, a vertical distance and subsequent impact onto the floor, ground, or onto another object).

- Any impacts to the waste cask / package shall be within design specifications and, thereby, not induce a breach of the waste cask/package in transit.

- The SSC itself may sustain substantial damage and may no longer be operable.

4.3.7 Safety Function: No Release

The safety function, "no release," is assigned to staging and storage racks assigned to either a DBGM-1 or DBGM-2 level.

The no release safety function has the following performance goals during and after a seismic event:

- No release or dispersement of radionuclides (either as gas and/or as particulates) to the environment due to shaking or deformation of the waste form or storage rack occurs.

- Distortion and damage of the waste form and rack(s) will be limited and will not preclude additional operations to retrieve the waste forms.

4.3.8 Safety Function: No Failure

The safety function, "no failure," is assigned to various SSCs (e.g., limiters, collars, dampers) assigned to either a DBGM-1 or DBGM-2 level. The no failure safety function has the following performance goal during and after a seismic event:

- The SSC will continue its designated safety function after a seismic event without significant degradation in the performance or requirement for repair. For structural elements, the load response shall be essentially elastic due to the seismic event.

4.3.9 Safety Function: No Significant Cracking / Displacement

The safety function, "no significant cracking / displacement," is assigned to aging pads at the DBGM-2 level. The no significant cracking / displacement safety function has the following performance goals during and after a seismic event:

- Aging pad is essentially intact. The concrete will remain structurally sound, but may contain several small cracks. The largest cracks are expected to be no greater than $^1/_8$ in (3 mm), and lengths shorter than 2 ft (0.6 m).

- Distortion of the pad will be very limited and not expected to be immediately apparent to the naked eye.

- Differential displacement across the pad shall be minimal, with differential displacements insufficient to cause a tipover of individual storage casks.

4.3.10 Safety Function: Controlled Failure

The safety function, "controlled failure," is assigned in special instances to SSCs (e.g., ventilation stacks) to precluded potential interactions with SSCs ITS. The controlled failure safety function has the following performance goals for ventilation stacks during and after a seismic event:

- Failure of a SSC due to a seismic event shall not obstruct an open flow path to the environment of the corresponding ventilation system.

- Failure of a SSC shall not impede the safety function of another SSC ITS.

4.3.11 Safety Function: Shielding Integrity Remains Intact

The safety function, "shielding integrity remains intact," is assigned to shielding SSCs (e.g., shield view ports, shield windows, shield doors) at the DBGM-1 and DBGM-2 levels. The shielding integrity remains intact safety function has the following performance goals during and after a seismic event:

- SSC remains essentially intact and in-place, and provides sufficient (direct shine) shielding to permit workers to egress the area without receiving a significant dose ("significant" is defined as less than 10 percent of the worker dose limit).

- Cracking of glass will be limited, and drainage of fluids (used in ports and windows for shielding) will be slow.

4.3.12 Safety Function: Maintain Waste Form

The safety function, "maintain waste form," is assigned to fuel handling machines at either the DBGM-1 or DBGM-2 level. The maintain waste form safety function has the following performance goals during and after a seismic event:

- The SSC continues to maintain (retain) the waste form.

- The waste form remains intact and in-place.

- Damage to the waste form is minimal.

- Significant release or dispersement of radionuclides (either as gas and/or as particulates) to the environment due to shaking or deformation of the waste form is precluded.

4.3.13 Safety Function: No Criticality

The safety function, "no criticality," is assigned to various waste containers (e.g., casks, canisters, WPs) and staging and storage racks assigned to DBGM-2 level.

For various waste containers, the no criticality safety function has the following performance goal during and after a seismic event:

- The waste in the container shall remain nuclear subcritical as a result of a drop or impact within design limits with the most reactive credible configuration of the fissile material and moderation to the most reactive credible extent.

- The container internal geometry shall retain the design waste configuration with only minor damage/distortion.

For staging and storage racks, the no criticality safety function has the following performance goal during and after a seismic event:

- The rack shall remain structurally intact (with minimal distortion of the rack) and prevent bare fuel assemblies (or other exposed waste forms) to become nuclear critical as a result considering the most reactive credible configuration of the fissile material and moderation to the most reactive credible extent.

4.3.14 Safety Function: No Runaway

The safety function, “no runaway” (uncontrolled descent), is assigned to transporters and locomotives assigned to the DBGM-1 and DBGM-2 levels. The no runaway safety function has the following performance goal during and after a seismic event:

- The SSC shall stop the transport train (the trailer/car containing a waste form) after a seismic event (however, a tipover is not precluded).

- The SSC shall not allow the speed of the transport train to exceed its maximum allowable limits.

- The coupler shall remain connected between the locomotive and transport train.

4.3.15 Safety Function: No Discharge

The safety function, “no discharge,” is assigned to SSCs such as vent ducts, as well as high-efficiency particulate air (HEPA) filters and filter housings, which can contain a significant particulate dose and are assigned to either a DBGM-1 or DBGM-2 level.

For filters, the no discharge safety function has the following performance goals during and after a seismic event:

- No significant release or dispersement of radionuclides (particulates) to the immediate environment (to the structure interior or exterior) due to shaking of the filter and/or deformation of the filter (housing) system occurs. (A significant release is defined as a release that results in less than a small fraction of the applicable dose limit over a period of 24 hours).

- No significant release or dispersement of radionuclides (particulates) back into the interior ventilation system (i.e., no back flow) shall be precluded by valves/dampers or other appropriate devices.

- External components of the system (e.g., housings, fans, etc.) shall be rigidly anchored to major building elements (walls, floors, partitions).

- The system shall maintain its structural integrity, and distortion/damage of the housing and hangers (if applicable) will be limited.

For vent ducts, the no discharge safety function has the following performance goals during and after a seismic event:

- No significant release or dispersement of radionuclides (particulates) to the immediate environment. (A significant release is defined as a release that results in less than a small fraction of the applicable dose limit over a period of 24 hours, and analyses shall consider potential accumulations within the duct re-entering the air stream).
- The duct shall maintain effective confinement of internal airflow with minimal outflow through joints.
- The duct shall maintain its structural integrity, and distortion/damage of the duct and hangers will be limited.

4.3.16 Safety Function: No Derailment

The safety function, "no derailment," is assigned to trolley rails and rail tracks, which are assigned to either a DBGM-1 or DBGM-2 level.

The no derailment safety function has the following performance goals during and after a seismic event:

- No significant structural deformation of the rail occurs (i.e., the rails will not shear, heave, or warp), that is serious enough to cause derailment or tipover of any waste transporter on the rail (e.g., WP trolley).
- No significant failure of the rail occurs (e.g., shearing, separation) that could induce a derailment if a transporter would pass over the damaged section.
- Distortion of the rail will be limited and not expected to be immediately apparent to the naked eye.
- Rail will remain for the most part anchored and functional (or easily repairable).
- The rail system shall not impede the braking of any waste transporter on the rail.

4.3.17 Safety Function: No Fall Down

The safety function, "no fall down," is assigned to large equipment (spent fuel handling machines, welders) that could impact SSCs if the specific equipment losses its anchorage and falls due to a seismic event. These SSCs can be assigned to either a DBGM-1 or DBGM-2 level.

The no fall down safety function has the following performance goals during and after a seismic event:

- The equipment as a system shall not collapse or fall down. The equipment shall remain on its track / guide system (if present).

- Anchorage for the equipment shall maintain the equipment in-place.

4.3.18 Safety Function: No Loss of Confinement

The safety function, "no loss of confinement," is assigned to facilities and structures assigned to either a DBGM-1 or DBGM-2 level where structural integrity and confinement after the seismic event must be credited for compliance or added for defense in depth. For seismic margin calculations, the function corresponds to the state of limited permanent distortion of a structure or facility, termed Limit State C by BSC (2004u, Table A-1).

In the present analysis, no credit is taken for confinement for limiting offsite dose to the public and, thereby, this safety function is not used. This definition was added for completeness.

The no loss of confinement safety function has the following performance goals during and after a seismic event:

- No structural collapse occurs (i.e., column and support members remain upright, beams remain functional, and walls remain standing), and failure of contents is not serious enough to cause severe injury or death, prevent evacuation, or induce a breach of a waste container.

- Confinement of internal airflow is required and will be maintained. Concrete walls will remain standing, but may be cracked. This cracking however, is small enough to maintain the pressure differential with normal HVAC. The largest cracks are expected to be no greater than approximately $^{1}/_{8}$ in (3 mm).

- Distortion of the structure will be very limited and not expected to be immediately apparent to the naked eye.

- Components will remain anchored and functional or easily repairable.

These goals are modified from various facility requirements for seismic design (DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, Appendix C). However, no direct correlation is adopted between this safety function and any defined performance category in DOE-STD-1020.

An additional requirement of this safety function is that the failure of adjacent structures and other SSCs (whether safety-related or not) shall be considered in seismic analyses as appropriate and shall not induce collapse of the designated structure.

4.4 OTHER CONDERATIONS

4.4.1 High Confidence of Low Probability of Failure Capacity

The SMA in this calculation uses a *high confidence of low probability of failure* (HCLPF) capacity as a conservative description of a SSC capacity to withstand vibratory motion. For the present analysis, the HCLPF capacity of a given SSC is defined as the ground acceleration at which there is approximately 1 percent probability of failure on the mean (single) fragility curve (e.g., Kennedy 2001, p. 40). "Failure" in this context is loss of the defined safety function. Ground acceleration is defined in terms of PGA and expressed in units of g, the acceleration due to gravity at sea level.

An alternative, earlier, definition of HCLPF capacity is the ground acceleration at 5 percent probability of failure on the 95 percent confidence fragility curve (e.g., Budnitz et al. 1985, Section 2.3; ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary,* p. 46). However, the current definition is essentially equivalent to this alternative when utilizing a single fragility curve (i.e., when the median curve is not subdivided between random and modeling uncertainty) and is recognized by the U.S. Nuclear Regulatory Commission (NRC) (Chen et al. 1991, p. 7).

4.4.2 Vibratory Ground Motion Due to Underground Nuclear Explosions

In addition to earthquakes, underground nuclear explosions (and other explosive detonations) can produce vibratory ground motions. Although such explosions can range to several hundred kilotons, it is concluded that due to the distance of the site to the test areas and the natural attenuation of these motions, that naturally-occurring motions from earthquakes will control seismic design criteria for both surface and subsurface facilities at Yucca Mountain (BSC 2003b, Section 6.2.1.1).

Underground nuclear explosion testing has not been conducted at the Nevada Test Site since October 1992, and there are no current plans to resume such testing. In the unlikely event that underground nuclear explosion testing is again started, these vibratory motions (due to underground nuclear explosion testing) will be evaluated and, if necessary, included in seismic analyses, when the distribution in space, time, and magnitude (or yield) can be specified for these new tests (YMP 1997b, Section A5). However, in the absence of any planned testing, inclusion of explosive sources for ground motion is beyond the scope of the present analysis.

4.4.3 Multi-Purpose Canisters

The specific processes that would be involved in processing commercial multi-purpose canisters, which could theoretically be received at the repository and transferred intact into waste packages, are beyond the scope of this analysis at this time (Assumption 5.17).

5. ASSUMPTIONS

The assumptions presented in this section are used throughout the analysis in Section 6. Rationale for these assumptions is based on the best available information pertaining to the repository design as of October 2004. These assumptions are suitable for use in this analysis and will be updated or verified in revisions of this analysis.

5.1 Sealed WPs, or monitored geologic repository site-specific casks (MSCs), cannot be breached by direct action of seismic forces up to and including ground motions associated with the 1.0×10^{-4} MAPE reference level earthquake. That is, seismic vibratory forces cannot shake apart or cause bolted or welded closures to open.

Rationale: Such containers are robust and subject to stringent nuclear codes and standards. This assumption is used to screen out seismic event sequences involving such containers. The favorable performance of the waste packages for a 1.0×10^{-4} MAPE reference level earthquake has been demonstrated for the waste packages emplaced in the drifts during the preclosure period (BSC 2004y, Section 7.1.2.2.1).

5.2 Sealed WPs or MSCs cannot be breached by a seismically-induced tipover, slap down, or impact when it can be assured by design or it is physically impossible that the WPs or MSCs can not exceed the design basis for the respective container.

Rationale: Design bases are established for internal events and earthquakes to prevent the initiation of a release for such postulated impacts. This assumption is used to screen out seismic event sequences involving such containers.

5.3 Seismically-induced failures of mechanical, electrical, or control systems of cranes, fuel handling machines, and other lifting devices may result in drops that exceed the design basis drop height of the waste form being processed. Such seismic failures are assumed to occur only when the earthquake exceeds the design bases assigned to a particular SSC (i.e., if the earthquake exceeds DBGM-1 or DBGM-2 assigned to a given SSC).

Rationale: There is insufficient information on equipment design to preclude such events, and one purpose of this analysis is to determine to what extent such seismic failures are potential vulnerabilities and then assign the appropriate DBGM to each SSC. This assumption is used as a basis for including in the analysis seismic event sequences involving such containers. This assumption is considered conservative.

5.4 Seismically-induced failures of mechanical, electrical, or control systems of the WP transporter system, designed to withstand the DBGM-2 reference earthquake, cannot cause an uncontrolled descent into the subsurface unless an earthquake exceeds the design bases.

Rationale: The transporter SSCs will be designed to prevent such occurrence and will be seismically qualified. Furthermore, the effect of an earthquake on such SSCs is likely to be transitory (e.g., relay chatter) and under the control of human operators (either on-board or in the Communications Control Center) so that even if an anomalous signal were initiated and not self-correcting, the human operator would intervene. In addition, the transporter shall be designed to stop on the loss of electrical power (BSC 2004o, Section 3.3.4.2.1). One purpose of this analysis is to determine to what extent such seismic failures are potential vulnerabilities and then assign appropriate DBGM to each SSC. This assumption is used as a basis for including in the analysis seismic event sequences involving the WP transporter. This assumption is considered conservative.

5.5 Seismically-induced failures of mechanical, electrical, or control systems of the WP emplacement gantry cannot result in a drop (or impact on a WP) that exceeds the design drop-height basis of the WP.

Rationale: Even if a seismically-induced failure or spurious signal could cause a drop, there is insufficient space in an emplacement drift and a limited range of motion for the WP emplacement gantry lifting mechanisms, such that drops beyond the WP design drop-height basis are precluded. Furthermore, the speed of motion of the gantry is limited so even a seismically-induced spurious signal to move is unlikely to result in a collision that is beyond the WP design basis. This assumption in used as a basis for screening out seismic event sequences involving the WP emplacement gantry.

5.6 Seismically-induced failures of mechanical, electrical, or control systems of the WP welding system cannot directly result in a release of radioactivity from a WP.

Rationale: Potentially, a seismically-induced failure or spurious signal can cause a problem during the welding process, as noted in BSC (2004s, Section 6.3.11), including potential burn-through during welding (noted in Table III-2, Items #18 and #29, under the heading, "Fires"). However, while a burn-through of the inner lid can occur, the required high temperatures and duration of heating to damage the waste cladding and waste form allow for sufficient time to shutdown the system and prevent any release after a seismic event. Also, the expected loss of power due to a seismic event will cause the welder to stop shortly after the event occurrence. It is also noted that the potential damage area due to the welder (and thereby the potential release) is relatively small.

In addition, design and operational requirements will ensure under normal operations that the welding equipment cannot initiate an event sequence by burning through the inner lid of the WP during the welding process or by overheating the fuel such that safe temperatures are exceeded (BSC 2004s, Section 5.1.1.53).

This assumption is used as a basis for screening out seismic event sequences involving the WP welding process, exclusive of tipover and dropped equipment sequences (Assumption 5.7).

5.7 Seismically-induced failures (tipover and dropped equipment sequences) of transport lorries, trolleys, and fixtures for supporting an unsealed WP during the welding process may result in a release of radioactivity. Furthermore, dropping lids or the falling of heavy equipment onto an unwelded WP may result in the release of radioactivity.

Rationale: This assumption is used as a basis for considering (screening-in) seismic event sequences involving SSCs associated with the WP welding functional area. It is recognized that the tipover and slap down of an unsealed waste package can result in dropping CSNFAs and thereby releasing radioactivity, whereas the tipover of (or drop of equipment or a lid onto) a sealed WP containing a DSNF canister may or may not result in a release. In addition, dropping lids or falling of heavy equipment onto an unwelded WP may result in the release of radioactivity depending on the mass of the dropped objects.

5.8 There are two identical DTFs, identified as DTF-1 and DTF-2, and seismic failures in the respective DTFs are conservatively taken to be completely correlated with each other. This means that if a seismic failure of a given SSC occurs in DTF-1, the counterpart SSC in DTF-2 fails with a conditional probability of 1.0. The probability of the SSC failure in DTF-1 depends on its DBGM assignment and intensity of the ground motion of the initiating earthquake.

Rationale: Assuming two identical and seismically correlated DTFs are performing the same operation at the time when an earthquake occurs, while conservative, simplifies the analysis so that details of throughput capacities and geometries do not have to be considered in this preliminary analysis. The assumption includes complete correlation and concurrent failure of all SSCs in the two structures. This assumption is used to assign DBGM categories to SSCs in the DTFs and in developing a SMA model.

5.9 Seismic-initiated failures of SSCs associated with functional areas other than the DTF are not correlated with seismic failures within the DTF, but can fail concurrently with failures of SSCs within the DTF.

Rationale: An earthquake is a common-cause initiating event that can induce event sequences in all facilities at the same time. This is a conservative assumption, as SSCs that are not housed in the DTF have essentially no seismic failure mechanisms that could be strongly correlated to failures of SSCs in the DTF. This assumption is used in developing a SMA model.

5.10 For this preliminary analysis, HCLPF capacities are developed from generic factors for SSCs based on available literature and assumed to be representative of SSCs ITS modeled in the SMA. Further, it is assumed that capacities can be based on PGA values in Table 1, Part A.

Rationale: For final design, the HCLPF capacities must be based on specific designs of buildings, location of equipment, support and anchors of equipment, and various load and damping factors that are included in the actual design. Such design-specific HCLPF capacities are not available as direct input to this analysis, so it is necessary to calculate representative values (see Section 6.6 for values).

5.11 The HCLPF capacity for loss of offsite power is assumed as 0.10 g.

Rationale: Loss of offsite power (LOSP) is typically attributed to the failure of ceramic insulators. Typical seismic capacity evaluations indicate that such insulators have a median seismic capacity of about 0.2 g (Kennedy et al. 1980, Table 7), that represents the median (50 percent) conditional failure probability. The HCLPF capacity represents the 0.01 of the mean failure probability, which is less than the median capacity. A value of 0.10 g is arbitrarily used in this analysis. Alternatively, the conditional probability of LOSP could be assumed as 1.0 and screened out of the SMA logic models (Prassinos et al. 1986, Table 2-3a, p. 24). A specific HCLPF capacity is assumed in this analysis to illustrate the application of the methods for determining the HCLPF capacity of a given functional area and facility. The offsite power grid is not designed to withstand the intense ground motions required for the design of SSCs ITS.

5.12 The preclosure period is nominally to extend 100 years for this analysis. If computations are limited to the emplacement period alone, a 50-year emplacement period can be adopted.

Rationale: The overall preclosure period of 100 years is adopted for this analysis based on stated guidance (Williams 2003b). For surface facilities, a 50-year emplacement period can be assumed, which will accommodate a nominal receipt period of 24 years (DOE 2002a, Table 1), together with an allowance for system testing, conservatism, and delays (BSC 2004s, Section 5.2.1.12).

5.13 The postulated breach of one or multiple canisters containing DSNF (excluding NSNF) is assumed to result in a public dose that exceeds 5 rem total effective dose equivalent (TEDE) at a distance of 11 km for an unmitigated release (i.e., the dose exceeds the limits shown in Table 2 for a Category 2 event sequence). The resulting dose is tabulated as unknown throughout Section 6, but is treated in the analysis as being equal to or greater than 5 rem TEDE.

Rationale: Dose consequences for DSNF have not been evaluated in *Preclosure Consequence Analyses for License Application* (BSC 2004t) and are regarded as unknown in this analysis.

5.14 Assemblies placed in staging vaults or storage racks within a DTF are assumed to be able to withstand the assigned DBGM level ground motions without significant release or becoming critical.

Rationale: Assemblies placed in staging vaults or storage racks in the DTF-1 and DTF-2 are to be intact and in good condition since the assemblies are inspected and tested on receipt. Impact loads on the assemblies from a DBGM level earthquake sustained while within storage are expected to be less than other design loads such as those required for transportation of the assemblies. Individual assembly spaces are to be sealed storage tubes (BSC 2004h, Section B.1.1.2, Room 1050) preventing the release of particulates, and vaults and racks will be designed to withstand an assigned DBGM level ground motion and remain intact. It is expected that the sealed tubes would be destroyed when the structure collapses.

5.15 Assemblies placed in storage pools within the DTF are assumed to be able to withstand the assigned DBGM level ground motions without significant release or becoming critical.

Rationale: Release of particulates and volatile radionuclides from any failed assembly is contained within the pool, so only gaseous radionuclides contribute to dose. The motion of assemblies placed in the wet remediation storage pool will be dampened by the presence of water, and transfer of any particulates from the assemblies to the air will be prevented by the overlying water. Storage racks and restraints in the pool and pool frame will be designed to withstand an assigned DBGM level ground motion to maintain non-critical geometry.

5.16 It is assumed that any potential seismically-initiated hazards occurring within the Transportation Facility are bounded by the design requirements of 10 CFR Part 71 and, therefore, cannot be breached by the direct action of seismic forces up to and including ground motions associated with the 1.0×10^{-4} MAPE reference level earthquake. That is, seismic vibratory forces cannot shake apart or cause bolted or welded closures to open, similar to Assumption 5.1 for WPs and MSCs.

Rationale: In the truck parking lot, railcar staging area, and on the roads and rails leading to the Cask and Waste Package Receipt Building (C&WPRB), the transportation casks are configured according to the regulations that govern offsite transportation (specifically, 10 CFR Part 71). The transportation cask is designed to be robust under the requirements of 10 CFR 71, and is to be able to survive the significant internal forces of a drop onto an unyielding surface and transport vibrations (Section 4.2.1). Until the cask impact limiters are removed and the cask lifted, drop conditions due to a seismic event are identical to potential drops during transport. Therefore, it is expected that any potential initiating event or internal/external hazard occurring in the receipt areas (that involve transportation casks with impact limiters installed) is bounded by the design and drop requirements of 10 CFR 71.

5.17 The activities that would be involved in handling commercial MPCs, which could potentially be received at the repository and transferred intact into waste packages, are not explicitly considered in this analysis.

Rationale: Currently, no MPCs have been licensed by the NRC (BSC 2004k, Appendix A). If they are to be accepted for disposal, it is assumed that they will be handled in a similar manner as vertical DPCs except that they will be placed directly into an appropriately-sized WP.

5.18 The potential maximum dose from low-level waste (LLW) handling is below the allowable Category 1 dose limits for workers.

Rationale: The potential maximum dose for SSCs from LLW handling is presently unspecified. The waste is under design and operational controls and it is expected that this requirement can readily be achieved.

5.19 Lifts by cranes and other handling devices shall be designed to operate and be used within maximum design basis drop heights (such as defined in Section 4.2).

Rationale: This is identified as a design requirement to provide a margin for potential drop sequences. This can readily be achieved by design for normal operations. Note that seismically-induced event sequences may result in drops that exceed these design basis drop heights (Assumption 5.3).

5.20 Cranes that handle NSNF canisters must withstand DBGM-2 seismic event.

Rationale: Due to the potential for seismic interactions if a large navy crane failed (e.g., fell from the overhead rail) together with the undefined dose due to the complete rupture of a NSNF canister due to a seismic event, this requirement is assumed for the present analysis. This is considered to provide additional defense-in-depth as part of a risk-informed basis.

5.21 The potential maximum dose from a HEPA filter system is above the allowable Category 1 dose limits for workers, but below the Category 2 offsite public dose limits.

Rationale: The potential maximum dose for SSCs of the HEPA filter system is presently unspecified. The retained particulate dose on the filter could potentially exceed allowable dose limits of workers. It is expected however, that the maximum dose contained on the filter is well below the Category 2 dose limits. As the retention of particulates on the filter is under design and operational controls and it is expected that this requirement can readily be achieved.

5.22 The potential maximum dose retained in the exhaust ventilation system is above the allowable Category 1 dose limits for workers, but below the Category 2 offsite public dose limits.

Rationale: The potential maximum dose of the ventilation system is presently unspecified. The amount of particulates in the ducts is expected to very small and that accumulation in the maximum unsupported duct run to be below allowable dose limits of workers. However, considering potential risk, it is assumed that the allowable Category 1 dose limits for workers can be exceeded. It is noted that the accumulation of particulates within the vent ducting is under design and operational controls and it is expected that this requirement can readily be achieved.

5.23 SSCs assigned to DBGM-1 can be re-assigned to DBGM-2 to reduce the aggregated dose DBGM-1 dose to provide additional defense-in-depth.

Rationale: The dose resulting from the aggregated DBGM-1 calculation may be compliant with regulatory limits, but may be deemed too high. In this case, SSCs assigned to DBGM-1 may be re-assigned to the higher DBGM-2 level to further reduce the aggregated DBGM-1 dose. This premise is considered appropriate to provide additional defense-in-depth as part of a risk-informed basis, and is employed in Table 4.

6. ANALYSIS

6.1 ANALYSIS PROCESS

6.1.1 Summary of Approach

The seismic design strategy for preclosure safety is based on establishing the appropriate combination of design basis ground motion levels, termed DBGM-1 and DBGM-2, and design procedures/requirements, together with a demonstration of sufficient seismic margin that meets the intent of 10 CFR Part 63.

An essential point of the analysis process is to identify SSCs ITS that are credited in the prevention or mitigation of seismically-initiated event sequences. These SSCs ITS are identified by postulating the seismically induced failure (i.e., the loss of the safety function) of a SSC, in combination with the seismically induced failures of other SSCs, and evaluating the dose consequences of the postulated failures. If the postulated failures and event sequences lead to calculated radiation exposures in excess of the limits identified at 10 CFR 63.111(a) for Category 1 event sequences, then DBGM-1 is assigned to the SSCs required to prevent the initiation of the sequence. If the postulated failures lead to calculated doses in excess of the limits at 63.111(b)(2) for Category 2 event sequences, then DBGM-2 is assigned to the SSCs.

Consistent with a risk-informed approach, the defined probabilities for DBGM-1 and DBGM-2 and design criteria and procedures are considered reasonable and appropriate relative to other facilities having comparable or greater levels of risk, and are in accordance with the provisions of 10 CFR 63.102(f) (BSC 2004u, Section 3.4).

The analysis will also demonstrate the margin of the SSC to vibratory ground motion. In utilizing the DBGM-1 and DBGM-2 design values, it is understood that a substantial amount of conservatism is incorporated into the design process. SSCs, therefore, can have a substantial capacity to sustain higher ground motions than the design value and still maintain the required safety function.

The margin to failure for each SSC is established by the SMA analysis, depending on the DBGM level:

1. For SSCs designated and designed to a DBGM-1 level, there is sufficient margin *inherent* in the DBGM-1 design requirement with respect to Category 1 event sequences. To clarify, the frequency of the initiating seismic event alone of a DBGM-1 event (i.e., at 1×10^{-3} MAPE) is beyond the requirements of Category 1 event sequences (i.e., at 1×10^{-2} annual probability of occurrence; see Section 4.1.11), and subsequent seismically-induced failure events in each sequence will further reduce the probability of occurrence of failure in the overall sequence. Therefore, all seismically-initiated event sequences that have been mitigated or prevented by the use of a DBGM-1 assignment to a SSC are less probable than the Category 1 occurrence criterion.

2. For SSCs designated as DBGM-2, explicit SMA calculations are performed to demonstrate that the defined safety function of each such SSC is maintained at a higher acceleration level, termed *BDBGM*. The BDBGM level of 1 x 10^{-4} MAPE is defined from precedent with NNPs (BSC 2004u, Section 3.3.2). The SMA will determine the ground motions at which the mean probability of not maintaining the safety function of the SSC will be less than 1 percent, which is termed the *high confidence low probability of failure* (or *HCLPF*) capacity value. Simply, the HCLPF capacity of each SSC will be demonstrated to significantly exceed the BDBGM acceleration.

This SMA approach is consistent with precedents adopted for nuclear facilities with comparable or higher risks to workers and the public, and it meets the regulatory intent of the concepts described in 10 CFR 63.102 and the preclosure performance objectives established in 10 CFR 63.111 (BSC 2004u, Section 3.3.2).

6.1.2 Analysis Methods and Steps

The overall seismic analysis process (implemented in subsequent sections) can be divided into of the following steps, which can be grouped into four separate stages:

<u>Stage 1. Identification and Evaluation</u>

(a) Identify and evaluate potential seismically-initiated internal event sequences for facilities that are part of the waste handling process. These event sequences are identified by (1) postulating a seismically-initiated event for internal hazards (BSC 2004p, Section 6.6) and (2) from a review of operations to identify seismically-unique sequences. [Note: seismic event trees can be developed to assist the identification of event sequences and in the development of generalized event sequences, as in Section 6.3.1.2.]

<u>Stage 2. Evaluate Dose and Assign Seismic Levels</u>

(a) Identify the maximum potential dose to the public or workers for each potential seismically-initiated event sequence by postulating seismic failure (loss of safety function) of each SSC and assessing the maximum potential dose of the failure.

(b) Assign a DBGM level to each SSC ITS that can be credited in the prevention or mitigation of a seismically-initiated event sequence, based on the maximum potential dose to the public and workers of the related seismically-initiated event sequence. Also, assess these assignments for an aggregated dose from DBGM-1 event sequences that in aggregate could potentially exceed the Category 2 dose limit to the public; reassign SSCs from DBGM-1 to DBGM-2, as required, to reduce the aggregated dose to below the Category 2 limit.

(c) Define the safety function for each SSC ITS as credited in seismic sequences (e.g., no structural collapse onto waste form).

(d) Identify and evaluate possible seismic interactions (i.e., if the potential failures initiated by seismic events of SSCs not important to safety could initiate failures of SSCs ITS). These SSCs are to be further evaluated during design (see Stage 3, step c).

(e) Identify any SSC that should be included on the Q-List as evaluated from the foregoing seismic analyses.

Stage 3. Design

(a) Design each SSC ITS per applicable design code(s) at the specified DBGM level.

(b) For SSCs assigned to DBGM-2, perform engineering design computations at the BDBGM level (to demonstrate that the safety function is maintained within limited inelastic deformation of the structure).

(c) Identify all SSCs that can affect the safety function of a SSC ITS. Any SSC whose failure can cause a SSC classified as ITS to not perform its safety function when required shall be classified as a Safety Category ITS and designed to prevent the unacceptable interaction.

(d) Determine the HCLPF capacity of each identified SSC ITS assigned to DBGM-2. Simplified methods may be used for the initial HCLPF calculations. [Where it can be demonstrated by simplified bounding analyses that the ratio of the HCLPF capacity to the BDBGM acceleration for an SSC exceeds 1.50, no HCLPF capacity will be computed and it will be reported that the HCLPF seismic margin exceeds 1.50 as opposed to reporting a specific value (BSC 2004u, Section B-1).]

Stage 4. Margin Demonstration

(a) For each SSC assigned to DBGM-2, compare the HCLPF capacity to the BDBGM level to ensure that sufficient additional margin is present (i.e., that the HCLPF capacity exceeds the BDBGM by at least 10 percent).

(b) Applying seismic event trees and fault tree analyses, develop Boolean expressions for the minimal cutsets of each seismic event sequence, which may include independent failure events as well as seismic failure events for various SSCs ITS. [Note: the term, "cutset," is defined in Attachment II).

(c) Screen out cutsets that include independent SSC or human failure events having a probability of less than 1×10^{-3}. [Note: With a minimum 10^{-3} MAPE for a seismic event, and a probability less than 10^{-3} for any subsequent independent event, the entire sequence has a joint annual probability of less than 10^{-6}, which is less than Category 2 criterion (i.e., the sequence is beyond Category 2).]

(d) Develop a repository-wide Boolean expression by combining the Boolean expressions of individual credible sequences, and reduce it to its simplest form using Boolean algebra.

(e) Determine the repository-wide HCLPF capacity by inserting HCLPF capacities of seismic failure modes of SSCs ITS that appear in the repository-wide Boolean expression and applying the min-max process.

Stages 1, 2, and 4 are performed as part of the present analysis. The design of the SSCs and the determination of individual HCLPF capacities (Stage 3) are to be conducted by others when sufficient design detail is available. However, Stage 3 results are not available at this time, and representative generic HCLPF capacities are used for the present calculation.

It is noted that the stages can be iterative with other preclosure safety analyses (e.g., internal hazard identification, fire hazard analysis and categorization) and the above stages are not always performed sequentially. The specific computational methods utilized in this analysis are discussed in more detail in Attachment II.

6.1.3 Analysis Limitations

A general framework for the seismic analysis for preclosure safety is established by this analysis, but some aspects of the defined process are not implemented fully, including:

- As noted, individual HCLPF capacities for SSCs are not available at this time (i.e., Stage 3 results), and representative generic HCLPF are used for the present calculation.

- Seismically-initiated fire sequences are not included due to the lack of definition of fire-related systems and components. However, potential seismic-fire sequences are identified in seismically-initiated internal event sequences (Attachment III) and in evaluating seismic interactions (Section 6.5). Fires will be included in updates to this analysis when sufficient detail is available.

- Recognition of potential seismic interactions is included in the analysis, but further design detail is required to determine the credibility of these event sequences; this discussion will be included in updates to this analysis.

- The probability of failure of seismically-initiated event sequences subsequent to the initiating seismic event are not computed for this analysis due to lack of definition of specific systems and SSCs. (Such analyses would require computation of the seismic fragility function for each affected SSC. The seismic fragility represents the conditional probability of the loss of the safety function given the seismic ground motions of a specified magnitude.)

- The topic of vibratory-induced control failures such as relay chatter is not explicitly discussed in the analysis due to the current level of design detail. In older systems, seismic-induced relay chatter is the opening and/or closing of relay contacts due to the influence of seismic accelerations, either directly or indirectly, and includes components such as electrical relays, contactors, and switches. This chatter due to ground motions can cause unacceptable performance of various controls, instruments, equipment, and valves. In modern solid-state control systems, relay contacts are generally not present, but other spurious signal effects may be produced by circuit board vibrations, and these effects should be considered in seismic analyses. The topic of chatter will be evaluated in more depth when sufficient information is available.

- The implemented SMA method does not explicitly include the evaluation of design and construction errors, evaluations of wear and aging, and possible adverse human response caused by earthquake-induced stress.

6.2 IDENTIFICATION AND EVALUATION

6.2.1 Identification of Possible Event Sequences

Possible seismically-initiated event sequences and the waste form and material at risk for each event sequence were identified and are included in Attachment III, based on the description of the facility and an evaluation of identified internal hazards. The current description of facilities and operations is provided in Section 4.2.1 and BSC (2004p). The internal hazards analysis (BSC 2004p, Section 6.6) provides an extensive description of potential hazards having potential radiological consequences or criticality conditions for each of the functional areas. However, the potential initiating events are not explicitly described in the hazard analysis and thus, each hazard was evaluated as to a possible initiation by a seismic event.

Attachment III also identifies potential seismically-unique event sequences not included in internal hazards analysis. These are based on potential hazards that are unique to seismic events, such as structural collapse and movement.

Though not explicitly stated in Attachment III, the loss of offsite electrical power (LOSP) can be expected to occur regularly with a seismically initiated event sequence. As observed in NUREG/CR-4334 (Budnitz et al. 1985, Summary), "Loss of offsite electrical power is found to occur at earthquake levels much lower than the levels at which most other equipment and structures are believed to fail. Therefore, most earthquake-induced accidents leading to serious consequences essentially begin with offsite power loss." For the present analysis, the HCLPF capacity for LOSP is taken as 0.1 g (Assumption 5.11), thereby having a very high probability of occurrence after either DBGM-1 or DBGM-2 seismic events.

It should be also noted that event sequences due to other, non-seismic, initiating events are not considered in the present analyses. In addition, no seismically-induced/influenced human failure event was identified in this analysis or as an initiator of an event sequence.

6.2.2. Evaluation of Event Sequences

6.2.2.1 General

In evaluating event sequences, those event sequences that could possibly follow an earthquake affecting the site are labeled as *potential* seismically-initiated sequences. Based on an evaluation of the range of these potential seismically-initiated sequences, event sequences that are excluded by physical limitations or by a very low probability of occurrence can be screened out from further consideration. The resultant event sequences that are not screened out by an evaluation process and are within defined ranges of annual probability of occurrence for Category 1 and Category 2 event sequences (Section 4.1.11) are termed credible.

In this analysis, event sequences that have been screened out in internal event analyses because of design features are, however, screened in for the seismic event sequences analysis until screened out for other reasons. The design features credited in the internal events analyses are a candidate for assignment of the DBGM level.

Potential event sequences are identified in Attachment III; credible sequences are evaluated in Sections 6.3 and 6.4 and are based on the screening criteria in the following sections.

6.2.2.2 Screening of Seismically-Initiated Event Sequences

In reviewing potential seismically-initiated event sequences, it is possible to identify and screen-out sequences that include a single independent failure event (or events) after the seismic initiation having a low probability of occurrence (less than 1×10^{-3}). In considering the probability of occurrence for a specific seismic event sequence, a small occupancy or exposure factor that reduces the probability of a specific event (in conjunction with an earthquake) can also be used in the screening process and is discussed further in Sections 6.3 and 6.4.

The following are considered in screening event sequences:

***Breach of WPs, MSCs, and Transportation Casks - Direct Action*:** Sealed WPs, MSCs and transportation casks shall be designed so that they cannot be breached by direct action of seismic forces up to and including ground motions associated with the BDBGM (Assumptions 5.1 and 5.16).

***Breach of WPs and MSCs - Tipover, Slap Down, or Impact*:** Sealed WPs or MSCs shall be designed so that cannot be breached by a seismically-induced tipover, slap down, or impact when it can be assured by design or it is physically impossible that the WPs or MSCs can not exceed the design basis for the respective container (Assumption 5.2).

WP Emplacement Gantry - Drop or Impact: Seismically-induced failures of mechanical, electrical, or control systems of the WP emplacement gantry cannot result in a drop or impact on a WP that exceeds the design basis of the WP (Assumption 5.5).

***WP Breach Due to Welding System*:** Seismically-induced failures of mechanical, electrical, or control systems of the WP welding system cannot result in a release of radioactivity from a WP (Assumption 5.6).

***Staging Racks/Staging Vaults/Staging Pool Release*:** Storage pools, staging racks, or staging vaults within the DTF containing CSNF assemblies shall be designed to withstand the DBGM-2 level ground motions without significant release (Assumptions 5.14 and 5.15).

***WP Transporter Uncontrolled Descent (Runaway)*:** The mechanical, electrical, or control systems of the WP transporter system shall be designed to withstand the DBGM-2 reference earthquake, to prevent an uncontrolled descent into the subsurface (Assumption 5.4).

***Rockfall on WP*:** Shielded compartment and waste package handling equipment of the transporter shall be designed such that a waste package remains inside of the shielded compartment during credible events. The waste package transporter shall be designed to withstand the bounding rockfalls in access drifts, thereby precluding a seismically-initiated rockfall onto the WP and, thereby, these events are not considered in this analysis. Furthermore, the WP is designed to withstand the bounding rockfall in an emplacement drift thereby precluding a breach of the WP for a 10^{-4} MAPE seismic event (BSC 2004y, Section 7.1.2.2.1)

Trolley - Shield Door Collisions**:** The design and operation of trolleys holding loaded, sealed WPs shall constrain travel speeds to levels such that a collision with shield doors would not overturn the trolley or cause it to drop its load (Section 6.2.2.3).

Criticality in Receipt Area**:** Criticality of casks in the Transportation Cask Receipt/Return Facility, or the Transportation Cask Buffer Area is screened-out (considered not credible) because the casks must be subcritical even with most reactive credible configuration of the fissile material and moderation to the most reactive credible extent (BSC 2004s, Section 6.3.2.6.1) and thereby, this event is not considered in this analysis.

Loss of Confinement**:** Structural confinement of radionuclides during or after a seismic event has not been identified as a requirement for safety for any waste handling facility and thereby is not considered in this analysis.

6.3 ANALYSIS OF DOSE TO OFFSITE PUBLIC

6.3.1 Identification of Seismic Fault and Event Trees

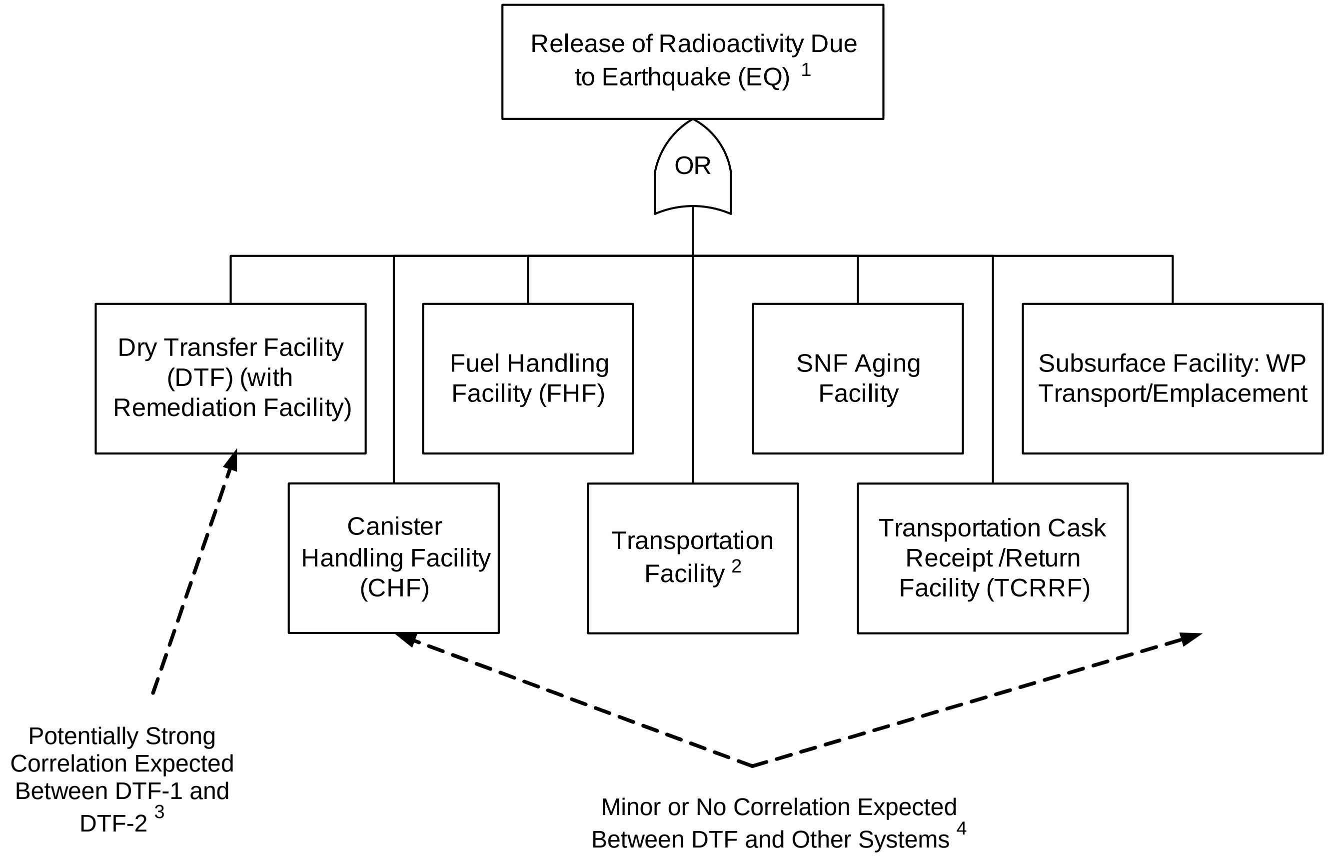
6.3.1.1 Master Logic Diagram

A single earthquake of sufficient intensity can result in the concurrent initiation of event sequences in multiple facilities and operational areas. As noted in Attachment II, a master logic diagram (MLD) is an application of fault tree logic that aids in performing the thorough and structured identification of potential seismic concerns. A MLD for the repository is depicted in Figure 1.

The top event in Figure 1, "Release of Radioactivity Due to Earthquake," is developed as an OR-gate to include each of the facilities or operations that contain radioactive material. The seismic event sequences for each of the facilities or functional area (e.g., DTF-1) is developed further using tables, event trees, and fault trees, as appropriate, to systematically identify the potential event sequences and the seismic and independent failure modes that come into play in offsite dose.

6.3.1.2 Seismic Event Tree Analysis

Following the approach described in Attachment II (Section II.4.3), several generalized SETs were created to describe the series of events that must occur in order to result in a release of radiation to the public. These generalized SETs are displayed in Figure II-3 and Figures V-1 through V-7. Although Figure V-4 presents a SET for seismically-induced fire scenarios, the present analysis does not apply the fire SET because sufficient design information is not available. The definitions of the event headings are provided in Table V-1. The generalized SETs are simplified in a series of steps described below to apply in the present analysis. The definitions of the event headings are provided in Table V-1.



NOTES:

1. System and building names are modified from BSC (2004d).
2. Transportation Facility includes the Railcar Staging Area and Truck Staging Area.
3. For this analysis, complete correlation is assumed (Assumption 5.8).
4. For this analysis, no correlation is assumed (Assumption 5.9).

Figure 1. Master Logic Diagram for Seismic Preclosure Safety Analysis for Dose

Using established event-tree conventions (NRC 1983, Section 3.4.3.1, pp. 3-24 to 3-25), the event heading description defines a success state for a function of an SSC or, in some cases, a conditioning event that defines a potential branching node in an event sequence. However, the event tree convention assigns an event name for the failure state (loss of the function) or less favorable conditioning event. Thus, the event heading, "Waste Form Does Not Breach After Drop," is associated with the failure event BR_DROP. Through fault tree analysis, a HCLPF capacity will be determined for the failure event BR_DROP. The complement event is labeled /BR_DROP and means the heading event is successful. (The symbol "/" before an event name indicates the complement or NOT function.)

The first step in simplifying the generalized sets is to eliminate the event headings OF_TRAN, OTF_CELL, OTF_STAG, and OTF_TROL. These four event headings are conditioning events that are used in the SETs to emphasize that the potential event sequences cannot occur if waste form is not present in a particular operation, or if there is a chance that waste form will not be impacted when an earthquake strikes.

For the present analysis, there is insufficient design and operational information to quantify the OF_TRAN, OTF_CELL, OTF_STAG, and OTF_TROL factors, so the probabilities are set equal to 1.0, and the event headings are eliminated from the SETs. However, such factors may be applied qualitatively when evaluating seismic event sequences.

The generalized trees are further simplified before solving event sequences. For example, Figure II-3 describes a SET for the drop of a waste form that includes several other event headings that can be eliminated to simplify the SET.

For this analysis, the preclosure safety strategy and design basis take no credit for confinement or filtration of any radioactivity released in an event sequence for offsite doses in meeting 10 CFR 63.111 for Category 2 event sequences (e.g., BSC 2004s). This means that the event headings CONF_CELL and HEPA_CELL can be eliminated from Figure II-3. Furthermore, for purposes of evaluating consequences of seismic event sequences to assign DBGMs to SSCs, it is assumed conservatively that a dropped waste form will breach with probability 1.0, so that the event heading BR_DROP can be eliminated from the SET. Although the design basis for operations involving DSNF canister is no breach, one purpose of this analysis is to assign the DBGM-2 requirement to SSCs ITS that are credited in preventing a canister breach in the event of an earthquake.

The simplified SET for the seismically-induced drop of a suspended waste form is shown in Figure 2. Two event sequences (Numbers. 2 and 3) result in an unmitigated release to the site boundary. Sequence 2 includes the earthquake (EQ) AND the success event /EQPT_SUP event AND the failure event DR_LOAD. The consequences of Sequence 2 include the release from the drop of the suspended waste and any other waste form it might strike. This simplified SET is named DSL for reference in the analysis.

Sequence 3 includes the earthquake (EQ) AND the failure event EQPT_SUP. In this event sequence, the event DR_LOAD is shown as a guaranteed failure to indicate that the suspended waste will surely fall if the entire machine falls after its support fails in the earthquake. The consequences of Sequence 3 include the release from the suspended waste and any other waste form it might strike and from any other waste form that the machine or supports might strike.

Figure 2 is a generic SET that can be used to represent all lifting and transfer operations in any of the facilities. The structure of the DSL tree is customized to a given facility or operation by using specific event labels that will be defined in Section 6.6. For example, the simplified SET in Figure 2 is used to represent seismic event sequences for the DTF Fuel Handling Machine by changing the name of the event headings to EQPT_SUP_FTM and DR_LOAD_FTM, respectively. Similarly, Figure 2 is used to represent seismic event sequences for the DTF canister transfer crane by changing the name of the event headings to EQPT_SUP_DTC and DR_LOAD_DTC, respectively. Using similar considerations, other generalized SETs from Attachment V were simplified as presented in Figures 6 through 9.

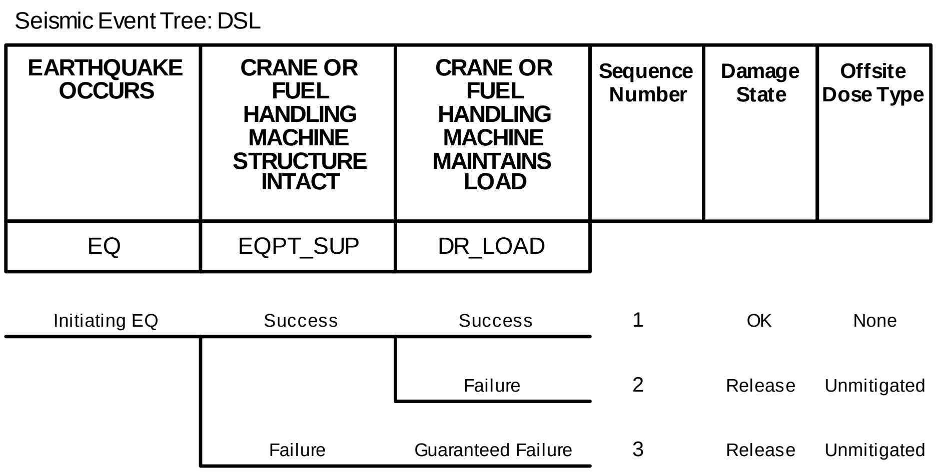


Figure 2. Simplified Seismic Event Tree for a Drop of Suspended Load

Figure 3 represents the fall of handling equipment onto a waste form. The event heading EQPT_SUP is the same as in Figure 2. It was simplified from Figure V-6. This simplified SET is named FHE for reference in the analysis.

Figure 4 represents the seismically-induced failure, derailment, or other effect that results in tipover, slap down, or impact of a waste form that is being transferred or being acted upon. It was simplified from Figure V-7. The failure event is labeled TROL_TO. This simplified SET is named TOS for reference in the analysis.

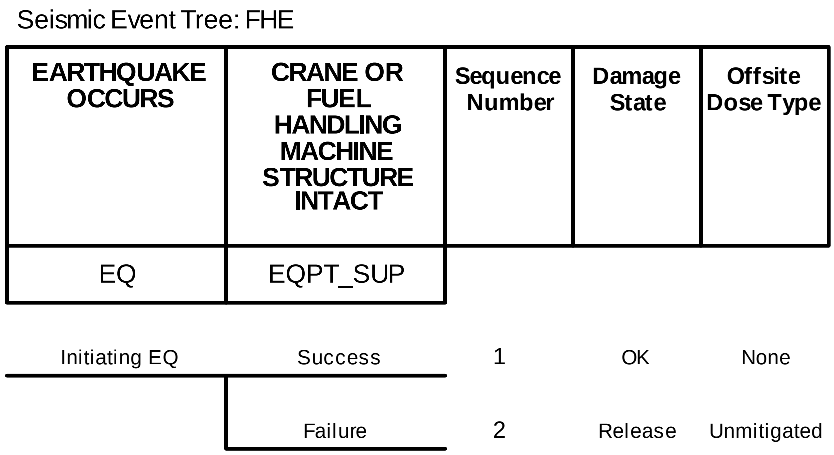


Figure 3. Simplified Seismic Event Tree for a Fall of Heavy Equipment onto Waste Form

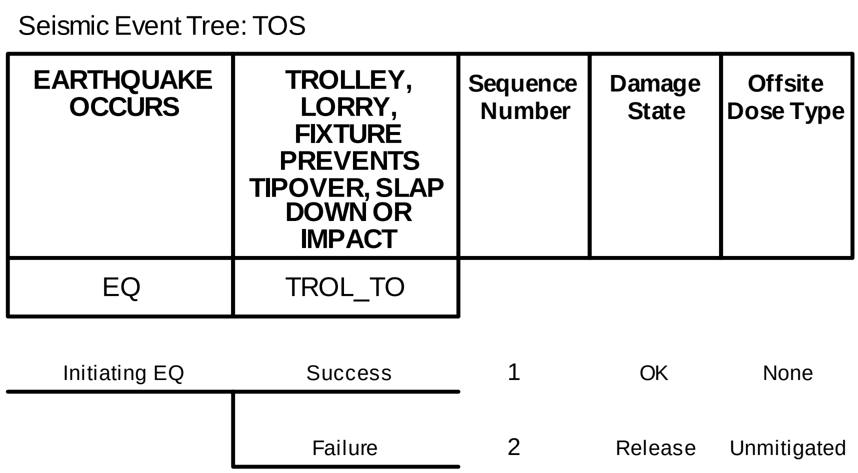


Figure 4. Simplified Seismic Event Tree for a Tipover or Slap Down in a Handling Operation

Figure 5 represents the collapse of a structural element onto a waste form. It is a simple event tree and is the same as Figure V-1, but is reproduced here with the other simplified tree SETs.

The failure event is labeled CELL_COLL. This simplified SET is named COL for reference in the analysis.

Figure 6 represents a seismically-induced LOSP and is simplified from Figure V-5. Three failure events are used: LOSP, EQT_FS, and DR_LOSP. In Sequence 3, the event DR_LOSP represents the seismic failure of mechanical or control systems that result in a load drop, regardless if the fail-safe features do not fail.

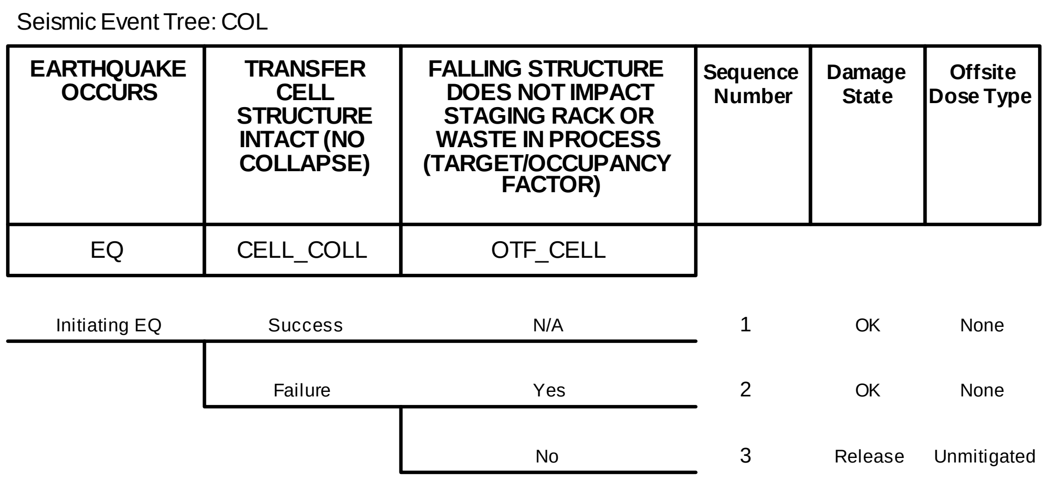


Figure 5. Simplified Seismic Event Tree for a Collapse of Structure of Transfer Cell

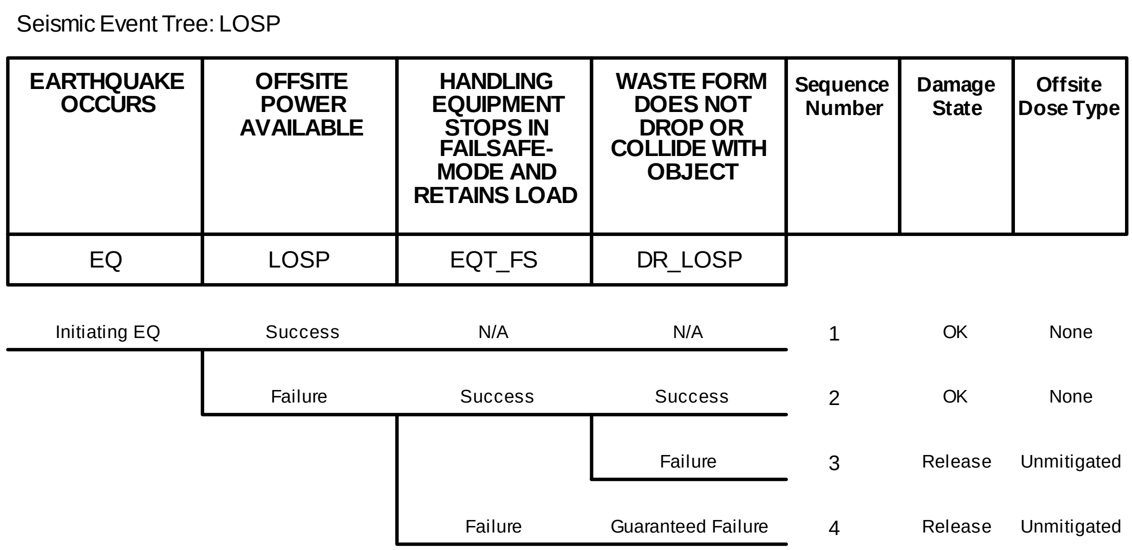


Figure 6. Simplified Seismic Event Tree for a Seismically-Induced Loss of Offsite Power

In Sequence 4, however, the event EQT_FS represents the seismic failure of the fail-safe features and the event DR_LOSP in this sequence is represented as a guaranteed failure. This simplified SET is named LOSP for reference in the analysis.

As described for the DSL tree, the simplified SETs are used to represent different functional areas by replacing the generic event name with an operation-specific name. The generic event name EQPT_SUP is replaced with EQPT_SUP_FTM to represent a seismic failure of the DTF Fuel Handling Machine.

6.3.1.3 Fault Tree Analysis

This section presents fault tree analysis for some event headings that appear in the simplified SETs. Figure 7 is a fault tree for the top event DR_LOAD_FHM, which is the event, Fuel Handling Machine Fails to Maintain Suspended Load. The top event is developed as an OR-gate into two fault events that represent, respectively, mechanical failures and control system failures. The mechanical failure fault event is developed as an OR-gate with inputs being basic events FHM_LH_EQ (seismically-induced failure) and FHM_LH_IN (independent failures of the mechanisms). The control system fault event is also developed as an OR-gate with inputs being basic events FHM_CONLH_EQ (seismically-induced failure such as relay chatter or vibratory contact between circuit boards), FHM_CONLH_IN (independent failures), and FHM_LH_HFE (i.e., a seismically-induced or influenced human-failure event that results in dropping the suspended load during or closely following an earthquake). Depending on the design of the operating controls, use of interlocks, or other design features, the event FHM_LH_HFE may not belong in the fault tree.

The structure of Figure 7 serves to emphasize that seismic event sequences may progress due to concurrent independent (random) failure events as well as seismically-induced failures. However, unless independent failures or human failure events are highly probable events, they can usually be screened out as being too unlikely to occur at the same time an earthquake strikes.

For example, it is estimated that the probability of dropping a lifted waste form is about 10^{-5} per lift (BSC 2004s, Assumption 5.1.8). This probability includes all independent causes including failures in the mechanical system and the control system, and may also include human failure events. This implies that the sum of probabilities of events FHM_LH_IN and FHM_CONLH_IN are on the order of 10^{-5} and can be screened out. Even if the failure rate of 10^{-5} per lift does not include human failure events, the event FHM_LH_HFE can be screened out on its own merit, as described in the next paragraph.

Event FHM_LH_HFE represents a human-induced or influenced initiation of a drop. If such a human failure event is applicable to the design, a typical value for human error probability is on the order of 10^{-3} for well-arranged manual controls (Swain and Guttmann 1983, Table 20-12). As noted in Section II.4.4, low-probability, independent failure events (including human failure events) having a probability of less than approximately 1×10^{-3}, are screened out in the SMA method. Therefore, for this analysis, FHM_LH_HFE is screened out.

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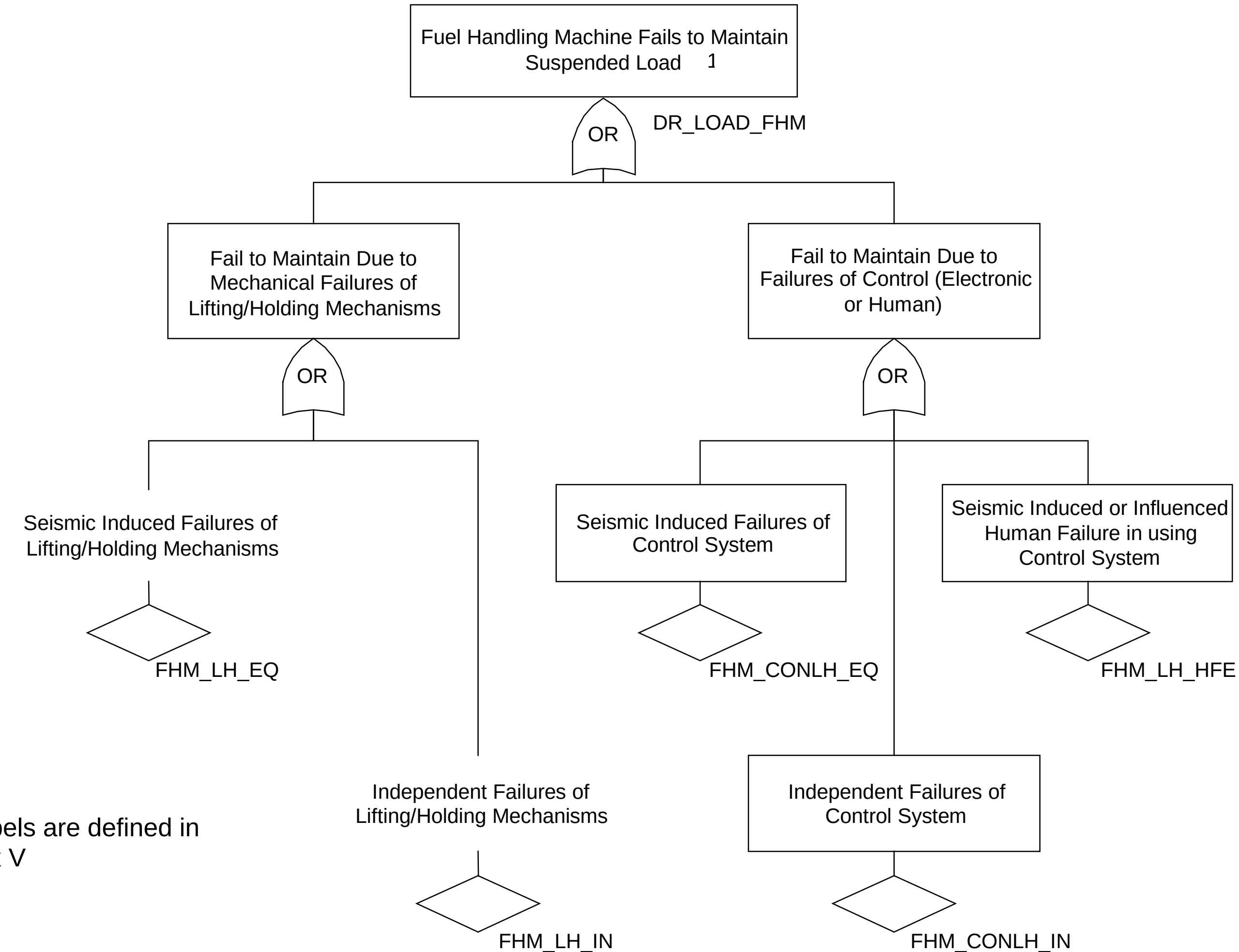


NOTE: [1]. Event labels are defined in Appendix V

Figure 7. Fault Tree: Fuel Handling Machine Fails to Maintain Suspended Load

As a result of the screening, the cutsets for the top event are two single cutsets, {FHM_LH_EQ} and {FHM_CONLH_EQ}, both seismically-induced failures.

Fault tree logic and screening, similar to Figure 7, can be applied to the analysis of the top event DR_LOAD_DTC, "Dry Transfer Crane Fails to Maintain Suspended Load." The fault tree is Figure VI-4 and entails changing the names of the top and basic events in Figure 7 to replace "FHM" with "DTC". After screening, the cutsets for the top event are the two single cutsets, {DTC_LH_EQ} and {DTC_CONLH_EQ}, both seismically-induced failures. Figure 8 displays a fault tree for the top event EQT_FS_FHM, "Fuel Handling Machine Fails to Stop in Fail-Safe Mode Following Earthquake."

The top event is developed as an OR-gate, having the input events FHM_FS_EQ (fail-safe fails due to earthquake) and FHM_FS_IN (fail-safe fails due to independent failures). Because the fail-safe design features are expected to be highly reliable, it is judged that FHM_FS_IN may be screened out. Therefore, the cutset for top event EQT_FS_FHM is one single cutset, {FHM_FS_EQ}.

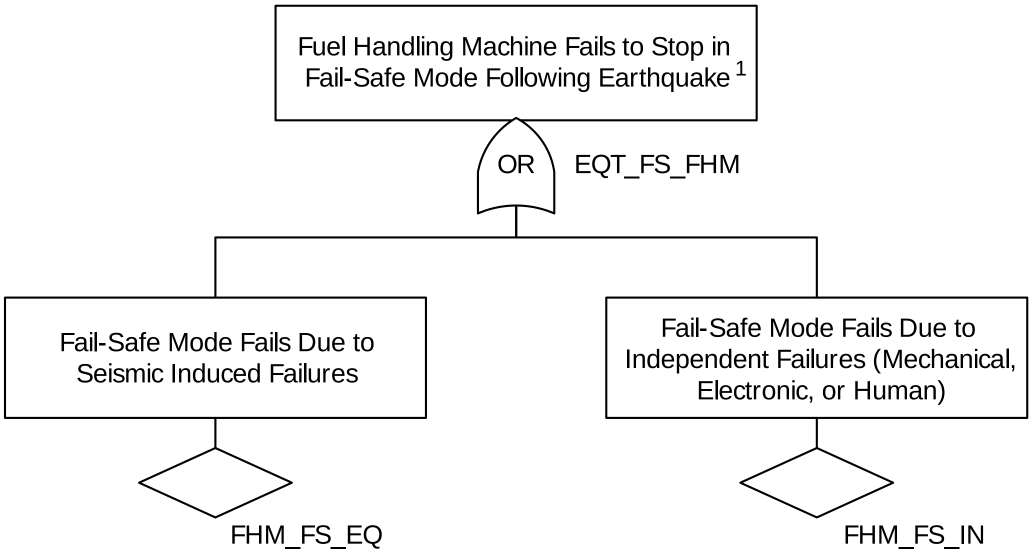
Figure VI-2 presents a fault tree, similar to Figure 8, for the top event "Dry Transfer Crane Fails to Stop in Fail-Safe Mode Following Earthquake," which results in one single cutset, {DTC_FS_EQ}.

6.3.2 Dose Consequences of Seismic Event Sequences

This analysis does not take credit for the confinement or filtration of radioactivity that may be released from a breached waste form. Therefore, any seismic event sequence that results in a release is assumed to produce an offsite dose to the public. The doses are proportional to the numbers and types of waste forms that are breached in a seismic event sequence. Such doses are scaled from unit doses that represent the offsite doses that result from the breach of an individual waste form.

Offsite dose information for the unmitigated release of radioactivity from CSNFAs was obtained from *Preclosure Consequence Analyses for License Application* (BSC 2004t, Tables 23 and 24). Offsite doses are evaluated at 11 km using a 95th percentile atmospheric dispersion factor.

These dose values, while bounding and unfiltered, include a leak path factor (BSC 2004t, Assumption 4.11). The leak path factor represents the assumption that an event, while it results in a loss of the confinement barrier, such as a seal, does not result in a gross rupture of the container and, thereby, a tortuous path is maintained for the release of gaseous radionuclides. The factor accounts for the fraction of airborne released material that discharges into the atmosphere from the heating, ventilation, and air-conditioning exhaust systems. To obtain the offsite doses for unmitigated release (without assuming any barrier to release), it is necessary to remove the credit for the leak path factor. Therefore, the dose values of BSC (2004t, Tables 23 and 24) have been scaled by a factor of 10 for SNF in a transportation cask and by a factor of 100 for DHLW in a canister.



NOTE: [1] Event labels are defined in Appendix V

Figure 8. Fault Tree: Fuel Handling Machine Fails to Stop in Fail-Safe Mode Following an Earthquake

The values from BSC (2004t) are shown in the "Basic Dose Inputs" section of Table 3. Basic Dose Inputs presents the offsite dose values that are scaled to calculate the doses for other waste forms. These values are scaled linearly to calculate the dose from a single CSNFA or from WPs, staging racks, and dual-purpose canisters in proportion to the number of CSNFAs present. The "Derived Doses" portion of Table 3 presents the calculated values.

The basic dose inputs represent airborne releases that result from any breach of the containment barrier of a given waste form, such as the cladding of spent fuel rods in a commercial fuel assembly or the shell or closure of a transportation cask or waste package. Such airborne releases and their resulting doses are representative of waste form breaches that are assumed for impacts on the waste form due to drops, slap downs, collisions and falling objects that can break or penetrate the waste form. Although conservative source terms, damage fraction (i.e., 100% of the fuel rods breached), release fractions, respirable fraction, and atmospheric dispersion factors are used in the basic dose inputs, such airborne releases may not be representative of releases that may result when a waste form is significantly damaged during a seismic event. For example, if a CSNF assembly were essentially flattened against the floor after being hit by a collapsing wall or support beam, the airborne release fraction or respirable fraction may be judged to be higher than that associated with breach of 100% of the fuel rods in the assembly. However, with the basic dose inputs as given, along with the assumption that offsite doses from breach of DSNF exceeds the performance goals for Category 2 event sequences, it is determined that such structural failures must be prevented as the DBGM-2 levels are assigned. Therefore, it is not necessary in this analysis to investigate doses that may result from structural collapse scenarios.

The unit doses for canisters containing DSNF are not explicitly calculated for Category 1 or Category 2 event sequences in this analysis. For this analysis, such doses are considered unknown and assumed to exceed 5 rem (Assumption 5.13) for purposes of demonstrating compliance with 10 CFR 63.111 and for assigning DBGMs to SSCs ITS that are credited in the prevention or mitigation of a seismically-initiated event sequence. Therefore, Table 3 lists "unknown" for the unit dose of an individual DSNF canister, and similarly, unit doses of larger waste forms containing one or more DSNF canisters are also unknown.

In addition, bounding doses were estimated based on engineering judgement for a limited number of systems where specific dose values were not available:

- The potential maximum dose from LLW handling is below the allowable Category 1 dose limits for workers (Assumption 5.18).

- The potential maximum dose from a HEPA filter system is above the allowable Category 1 dose limits for workers, but below the Category 2 offsite public dose limits (Assumption 5.21).

- The potential maximum dose retained in the exhaust ventilation system is above the allowable Category 1 dose limits for workers, but below the Category 2 offsite public dose limits.

Table 3. Offsite Unit Dose Consequences for Various Waste Forms

Type of Waste Form or Functional Area	Number of CSNFAs Present	Offsite Dose at 11 km (mrem) [a]	Offsite Dose at 11 km for Analysis (rem) [a]
Basic Dose Inputs			
Transportation Cask - 36 PWR CSNFAs (Maximum PWR Source Term) [a,b]	36	476	0.48
Transportation Cask - 74 BWR CSNFAs (Maximum BWR Source Term) [a,b]	74	371	0.37
DSNF Canister [c]	N/A	Unknown [c]	> 5 Rem
DOE HLW Canister - Maximum [d]	N/A	77	0.08
NSNF Canister [e]	1	11	0.01
Derived Doses (Scaled from Basic Dose Inputs)			
CSNFA - Maximum PWR Source Term	1	13.22	0.013
CSNFA - Maximum BWR Source Term	1	5.01	0.005
DPC - PWR CSNFAs	36	476	0.48
DPC - BWR CSNFAs	74	371	0.37
WP - DOE HLW Canisters and 1 DSNF Canister	N/A	Unknown [c]	> 5 Rem
WP - DOE HLW Canisters and 2 DSNF Canisters	N/A	Unknown [c]	> 5 Rem
WP - PWR CSNFAs (Maximum PWR Source Term)	21	278	0.28
WP - BWR CSNFAs (Maximum PWR Source Term)	44	220	0.22
Transportation Cask - PWR CSNFAs	24	317	0.32
Transportation Cask - BWR CSNFAs	68	341	0.34
Transportation Cask - DSNF Canister [c]	N/A	Unknown [c]	> 5 Rem
MSC - PWR CSNFAs	24	317	0.32
MSC - BWR CSNFAs	68	341	0.34
Dry Transfer Cell Staging Rack -PWR CSNFAs	48	635	0.63
Dry Transfer Cell Staging Rack - BWR CSNFAs	72	361	0.36
Dry Transfer Cell Staging Rack -Total (Sum of BWR + PWR)	120	996	1.00
Dry Transfer Cell Staging Rack - DSNF Canisters	10	Unknown [c]	> 5 Rem

Table 3. Offsite Unit Dose Consequences for Various Waste Forms (Continued)

Type of Waste Form or Functional Area	Number of CSNFAs Present	Offsite Dose at 11 km (mrem) [a]	Offsite Dose at 11 km for Analysis (rem) [a]
Wet Cask Remediation Staging Rack - PWR CSNFAs	48	635 [g]	0.63
Wet Cask Remediation Staging Rack - BWR CSNFAs	72	341 [g]	0.34
Wet Cask Remediation Staging Rack - DOE Canisters	10	Unknown [c]	> 5
WP Handling and Staging Cell (PWR CSNFA)	105	1390	1.39
WP Staging (10 WPs)+Loadout (1 WP) = (11 PWR WPs)	231	3054	3.05
WP Staging (10 WPs)+Loadout (1 WP) = (11 DOE Canister WPs)	N/A	Unknown [c]	> 5
WP Transporter (1 PWR WP)	36	476	0.48
WP Transporter (1 DOE Canister WP)	N/A	Unknown [c]	> 5
Doses Not Analyzed			
WPs in Emplacement Drifts	--	Not available	> 5 [f]
SNF Aging Facility - Casks on Pads	--	Not available	> 5 [f]

NOTES:
[a] TEDE at 11 km using 95 percentile atmospheric dispersion factor
[b] Based on unfiltered TEDE for 36 PWR and 74 BWR in Table 23 of BSC (2004t, scaled by a factor of 10 to remove assumption of leak path factor.
[c] Any unmitigated release from a DSNF canister will result in an unacceptable dose, i.e. greater than 5 rem TEDE (Assumption 5.13).
[d] Scaled 1:5 for maximum unfiltered TEDE for one DOE canister from Table 24 of BSC (2004t (i.e., Savannah River Site HLW canister), scaled by a factor of 100 to remove assumption of leak path factor.
[e] Based on drop and breach of one NSNF canister without HEPA filters, Table 24 of BSC (2004t, scaled by a factor of 10 to remove assumption of leak-path factor.
[f] Given the potential unmitigated release from a DSNF canister (see above), any release will result in an unacceptable dose, i.e. greater than 5 rem.
[g] Doses do not include particulates.

BWR = boiling water reactor; DOE = U.S. Department of Energy; DPC = dual-purpose canister; DSNF = DOE-owned spent nuclear fuel; HEPA = high-efficiency particulate air; HLW = high-level radioactive waste; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; PWR = pressurized water reactor; TEDE = total effective dose equivalent; WP = waste package.

The bottom portion of Table 3 indicates two functional areas for which doses are not analyzed. The emplacement drifts will be loaded with approximately 11,200 WPs (per Section 4.1.2) and contain both CSNFAs and canistered waste. The dose from the breach of a single WP containing DSNF is assumed to exceed 5 rem. Therefore, SSCs ITS in the WP emplacement area (subsurface storage) are assigned DBGM-2. The only SSC ITS affected is the WP, which has a design requirement to not breach from any drops within the WP design basis, impacts between the WP and the support pallet, or from the impact of rockfall and falling ground support components, including those initiated by a DBGM-2 earthquake. In addition, the WP confinement structure must withstand stress that is induced by a subsurface DBGM-2 earthquake.

No explicit doses are provided for the surface aging facility. The initial aging facility is planned for 1,000 MTHM, which represents about 2,500 CSNFAs (Section 4.1.2). The concurrent breach of this many CSNFAs would result in an offsite dose exceeding 5 rem. Additional aging pads may be added, each containing approximately 5,000 MTHM (BSC 2004k, Section 4.1.1.1). Furthermore, operational flexibility may require the temporary staging of DSNF canisters. As noted throughout, any seismically-induced event sequence that results in an impact on one or more DSNF canisters is assumed to result in an offsite dose that is greater than 5 rem (Assumption 5.13). Therefore, as shown in Section 6.3.3, the entire aging facility is assigned DBGM-2.

6.3.3 Assigning Design Basis Ground Motions to Structures, Systems, and Components Important to Safety

Table IV-1 lists the SSCs that have been identified as being ITS in previous analyses (BSC 2004r, Appendix A). Per the seismic methodology (BSC 2004u, Section 3.1.1), all SSCs ITS that are credited in the prevention or mitigation of a seismically-initiated event sequence must be assigned one of the two DBGM categories, as appropriate, to the dose that would result from their seismic failure.

As defined in Section 4.1.7, the two DBGM levels employed in these analyses are DBGM-1 at 1×10^{-3} MAPE and DBGM-2 at 5×10^{-4} MAPE. As appropriate, SSCs that have been identified as contributors to a potential seismic-unique event sequence from the seismic safety analysis reported herein must be added to the list of SSCs ITS.

The assignment of DBGMs to SSCs ITS proceeds in stages as shown in Table 4:

1. Calculate the consequences associated with each individual seismic event sequence, as shown in the Offsite Dose column of Table 4. This stage is a deterministic analysis. Based on the doses in this column, DBGM-1 or DBGM-2 is initially assigned to the SSCs whose individual seismic failure results in the calculated dose. Doses for sequences involving DSNF canisters are given as unknown and the SSCs ITS that prevent these doses are assigned DBGM-2. Consequences for the DTF transfer of CSNF that uses a fuel-handling machine are treated separately from those of the DTF transfer of DSNF canisters that uses an overhead crane. The consequences for only one DTF are included in the "Offsite Dose" column.

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Transportation Facility									
Railcar Staging Area	Transportation Cask (All Waste Forms Including DSNF) [c]	Sealed	Variable	> 5	DBGM-2	N/A	--	--	--
Truck Staging Area	Transportation Cask (All Waste Forms Including DSNF) [c]	Sealed	Variable	> 5	DBGM-2	N/A	--	--	--
Receipt Systems									
Cask and Waste Package Receipt Building - Warehouse & Non-Nuclear Receipt Facility	None	--	0	0	CD [d]	N/A [d]	--	--	--
Cask and Waste Package Receipt Building - Transportation Cask Receipt/Return Facility	Transportation Cask (All Waste Forms Including DSNF) [c]	Sealed	6	> 5	DBGM-2	N/A	--	--	--
Transportation Cask Buffer Area	Transportation Cask (All Waste Forms Including DSNF) [c]	Sealed	36	> 5	DBGM-2	N/A	--	--	--
WP Receipt Facility	None	--	0	0	CD [d]	N/A [d]	--	--	--
Heavy Equipment Maintenance Facility (HEMF)	None	--	0	0	CD [d]	N/A [d]	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Canister Handling Facility									
Entrance Vestibule	Transportation Cask (Canister Forms NSNF, HLW and DSNF) [c]	Sealed	1	> 5	DBGM-2	N/A	--	--	--
Transfer Area - Handling	Transportation Cask (Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
Transfer Area - Pits	MSC (Canister Including DSNF)	Unsealed	2	> 5	DBGM-2	N/A	--	--	--
	WP (Canister Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
Transfer Area - Staging Pits	Canister (DSNF)	Sealed	10	> 5	DBGM-2	N/A	--	--	--
WP Closure	WP (Canister Including DSNF)	Unsealed	2	> 5	DBGM-2	N/A	--	--	--
WP Transporter Load	WP (Canister Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
Dry Transfer Facility (2)									
Empty WP Processing	None	--	0	0	CD	--	--	--	--
Entrance Vestibule - 200 ton Cask Handling Crane	Transportation Cask (Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
Entrance Vestibule - Site rail transfer cart (SRTC) [e]	MSC	Sealed	1	0.34	DBGM-1	0.68	DBGM-1	0.68	X
Turntable & Preparation Rooms	Transportation Cask (Including DSNF)	Partially Sealed	1	> 5	DBGM-2	N/A	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Cask and MSC Docking Room	Transportation Cask (Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
NSNF Receipt - 200 ton Navy Cask Handling Crane	NSNF Assembly or Canister	Sealed	1	0.01	DBGM-1	0.01	DBGM-1	0.01	X [e]
NSNF Processing - 70 ton Navy Cask Handling Crane	NSNF Assembly	Partially Sealed	1	0.01	DBGM-1	0.01	DBGM-1	0.01	X [e]
Waste Transfer - WP Docking	WP (CSNFA - 21 PWR) (2 ports)	Unsealed	42	0.56	Bounded by DSNF Requirements (see below)	--	--	--	--
	or WP (Canister) (2 ports) (Including DSNF)	Unsealed	2	> 5	DBGM-2	N/A	--	--	--
Waste Transfer - Spent Fuel Transfer Machine	CSNF Assembly	N/A	1	0.013	DBGM-1	0.03	DBGM-1	0.03	
Waste Transfer - Cask & MSC Docking - Canister/HLW Handling Crane	Transportation Cask (2) (Including DSNF)	Unsealed	2	> 5	DBGM-2	N/A	--	--	--
	or MSC (2)	Unsealed	2	0.68	Bounded by DSNF Requirements (see above)	--	--	--	
Waste Transfer - Staging	CSNF in CSNF Staging Rack	N/A	120	1.00	DBGM-1	2.00	DBGM-1	2.00	X
	Canisters in Canister Staging Rack (Including DSNF)	N/A	10	> 5	DBGM-2	N/A	--	--	--
Empty Transportation Cask/MSC/DPC Removal Offsite	None	--	0	0	CD	N/A	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Cask Restoration Room / Loaded MSC Removal	MSC	Partially Sealed	1	0.34	DBGM-1	0.68	DBGM-1	0.68	X
WP Handling and Staging Cell - Staging	WP (CSNFA)	Sealed / Unsealed	5	1.39	Bounded by DSNF Requirements (see below)	N/A		--	--
	WP (Canister Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
WP Handling and Staging Cell - Bridge Crane	WP (Canister Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
WP Handling and Staging Cell - WP Closure Cells	WP (Canister Including DSNF)	Unsealed	4	> 5	DBGM-2	N/A	--	--	--
WP Loadout (WP Loadout Cell, WP Transporter Vestibule, Exit Vestibule)	WP (CSNFA)	Sealed	1	0.28	Bounded by DSNF Requirements (see below)	N/A	--	--	--
	or WP (Canister Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
WP Remediation	WP (CSNFA)	Sealed/ Unsealed	1	0.28	Bounded by DSNF Requirements (see below)	--	--	--	--
	or WP (Canister Including DSNF)	Sealed/ Unsealed	1	> 5	DBGM-2	--	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Dry Remediation	MSC	Unsealed	1	0.34	Bounded by DSNF Requirements (see below)	--	--	--	--
	or Transportation Cask (Canister Including DSNF)	Unsealed	1	> 5	DBGM-2	--	--	--	--
	or SNF/HLW DPC	Unsealed	1	0.48 [f]	Bounded by DSNF Requirements (see above)	--	--	--	--
Wet Remediation - Laydown Area, Cask Wet Remediation Entrance Vestibule	Transportation Cask (Canister including DSNF)	Sealed/ Unsealed	1	> 5	DBGM-2	--	--	--	--
	MSC	Sealed / Unsealed	1	0.34	Bounded by DSNF Requirements (see above)	--	--	--	--
	NSNF	Sealed/ Unsealed	1	0.01	Bounded by DSNF Requirements (see above)	--	--	--	--
	DSNF / HLW Canisters	Sealed/ Unsealed	1	> 5	Bounded by DSNF Requirements (see above)	--	--	--	--
	Special Canister (Damaged Waste including DSNF) [g]	Sealed/ Unsealed	1	> 5	Bounded by DSNF Requirements (see above)	--	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Wet Remediation - Staging Racks	PWR CSNFA	N/A	48	0.36	Bounded by DSNF Requirements (see below)	--	--	--	--
	BWR CSNFA	N/A	72	0.34	Bounded by DSNF Requirements (see below)	--	--	--	--
	DOE Canisters (Including DSNF)	N/A	10	> 5	DBGM-2	--	--	--	--
DPC Cutting	DPC	Sealed/ Unsealed	1	0.48	DBGM-1	0.96	DBGM-1	0.96	X
Fuel Handling Facility									
Entrance Vestibule	Transportation Cask (CSNF; DSNF canisters except MCOs; NSNF; and DOE HLW)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
Preparation / Restoration Area	Transportation Cask (Including DSNF)	Partially Sealed	1	> 5	DBGM-2	N/A	--	--	--
Empty Waste Package Processing	None	--	0	0	CD	--	--	--	--
Waste Transfer - Spent Fuel Transfer Machine	CSNF Assembly	N/A	1	0.013	DBGM-1	N/A	--	0.013	--
Transfer Cell - Pits	MSC (Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
	WP (Including DSNF)	Unsealed	1	> 5	DBGM-2	N/A	--	--	--
Loaded MSC Receipt	MSC (Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	
WP Closure Cell	WP (Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
WP Loadout Area	WP (Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	Waste Form	Condition	Number of Waste Units	Offsite Dose [a] (rem)	DBGM by Operations Area	Offsite Dose for 2 DTFs (rem)	DBGM by Operations Area for 2 DTFs	Dose from DBGM-1 SSCs (rem)	Reassigned to DBGM-2 [b]
Subsurface Operations: WP Subsurface Transport and Emplacement								0	
WP Transporter	WP(CSNFA)	Sealed	1	0.48	Bounded by DSNF Requirements (see below)	N/A [d]	--	--	--
	WP (Canister, Including DSNF)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
WP in Emplacement Drifts	Not Analyzed [h]	--	--	Not Analyzed [i]	DBGM-2	N/A	--	--	--
SNF Aging Facility									
Transporters [i]	MSC per trip [j]	Sealed	1	0.34	Bounded by DSNF Requirements (see below) [j]	N/A	--	--	--
	DPC per trip [j]	Sealed	1	0.48	Bounded by DSNF Requirements (see below) [j]	N/A	--	--	--
	Containing DSNF (per trip)	Sealed	1	> 5	DBGM-2	N/A	--	--	--
Initial Aging Pad	Aging Module - Horizontal	Sealed	20	9.6	DBGM-2	N/A	--	--	--
	Aging Module - Vertical (Including DSNF)	Sealed	80	> 5	DBGM-2	N/A	--	--	--

Table 4. Offsite Dose Assignment of DBGMs to Functional Areas/Systems (Continued)

Functional Area/System	**Waste Form**	**Condition**	**Number of Waste Units**	**Offsite Dose [a] (rem)**	**DBGM by Operations Area**	**Offsite Dose for 2 DTFs (rem)**	**DBGM by Operations Area for 2 DTFs**	**Dose from DBGM-1 SSCs (rem)**	**Reassigned to DBGM-2 [b]**
Aging Pad #2 (+ Others)	Aging Module - Horizontal (Including DPC)	Sealed	120	57.6	DBGM-2	N/A	--	--	--
	Aging Module - Vertical (Including MSC With DSNF)	Sealed	400	> 5	DBGM-2	N/A	--	--	--

Sum of DBGM-1 Doses (From Seismic Failures of DBGM-1 SSCs above)-	4.38
Adjusted DBGM-1 Doses (Doses flagged with "X" that are re-assigned to DBGM-2)	<4.34>
Net Adjusted DBGM-1 Dose	0.04

NOTES: [a] Offsite doses are taken from Table 3.

[b] Items marked with “X” subtracted from total DBGM-1 dose, and re-assigned to DBGM-2. The re-assignment is to ensure compliance and provide addition defense in-depth.

[c] Unit doses for canisters containing DSNF not explicitly calculated (per Section 5, Assumption 5.13). For this analysis, all such doses are assumed to exceed 5 rem.

[d] CD = conventional design (i.e. no DBGM-1 or -2 assignment); N/A = not applicable.

[e] In accordance with Section 5, Assumption 5.20.

[f] Assumed DPC with 36 PWR CSNFAs.

[g] Contents of special canister (damaged waste) is unspecified; for conservatism, dose is assumed to exceed 5 rem.

[h] Not analyzed, see Table 3.

[i] Transport may employ different SSCs for handling the respective MSC, DPC, and DSNF waste forms, so a DBGM is assigned to each. If the same SSCs are used for all waste forms, then the limiting case of DSNF applies, and DBGM-2 is assigned to SSCs.

[j] Operational considerations may limit or prohibit the transport of DSNF to the Aging Pad, but for the conservatism, it is included in this analysis.

CSNF = commercial spent nuclear fuel; DBGM = design basis ground motion; DPC = dual-purpose canister; DSNF = U.S. Department of Energy-owned spent nuclear fuel; DTF = Dry Transfer Facility; MCO = multi-canister overpack; MSC = monitored geologic repository site-specific cask; N/A = not applicable; NSNF = naval spent nuclear fuel; SRTC = site rail transfer cart; SSCs = structures, systems, and components; WP = waste package.

2. Consider the effects of correlation between seismic failures in various facilities. Correlations between the two DTFs need to be considered (Section 5, Assumption 5.8). Column 7 of Table 4 (Offsite Dose for 2 DTFs), multiplies all doses related to one DTF by a factor of two. The entries in this column indicate the dose associated with seismic event sequences involving both DTFs.

3. Consider aggregated offsite dose from the postulated failure of all DBGM-1 SSCs. If the aggregated dose is less than 5 rem TEDE, then the initial DBGM assignments are maintained. However, if the initial analysis were to indicate that the aggregated dose is equal to or greater than 5 rem TEDE (i.e., noncompliance of aggregated DBGM-1 SSCs doses with 10 CFR 63.111(b)(2)), then re-assign one or more DBGM-1 SSCs to DBGM-2 to achieve compliance. If compliance is still not achieved, it will be necessary to consider changes in the design and/or to take credit for the occupancy or target factors described in Section II.4.3. (Re-assignment of DBGM-1 SSCs may also be performed based on risk-informed decisions, e.g., Assumption 5.20.)

Column 9 of Table 4 (Dose from DBGM-1 SSC) lists the offsite dose that would result when assumed seismic failures of DBGM-1 assigned SSCs occur in an individual functional area. The unadjusted sum of these doses is shown to be 4.38 rem. This dose may result after the occurrence of any earthquake that exceeds the ground motions of DBGM-1. This condition while it complies with 10 CFR 63.111(a) or (b), is considered large for the analysis and is adjusted.

As part of this adjustment, utilizing a risk-informed approach, the cranes handling the NSNF canisters are assigned to DBGM-2 (Assumption 5.20) and are flagged with an “X” in column 10 of Table 4 (“Reassigned to DBGM-2”). Similarly, the SRTC, the DPC cutting system, the CSNF staging rack, and loaded MSC removal system are also assigned to DBGM-2 and are flagged with an “X” to reduce the total aggregated DBGM-1 dose (Assumption 5.23). The sum of these re-assigned dose values is 4.34 rem. Subtracting these items, the total resultant dose of items assigned to DBGM-1 is reduced to 0.04 rem (4.38- 4.34).

The results of these assignments in Table 4 are used as the basis for assignment of DBGM levels to SSC ITS in Table IV-1.

6.4 ANALYSIS OF RADITION WORKER AND OTHERS ONSITE DOSE

6.4.1 Identification of Seismic Fault and Event Trees

6.4.1.1 Master Logic Diagram

As noted in Attachment II, a master logic diagram (MLD) is an application of fault tree logic that aids in performing the thorough and structured identification of potential seismic concerns. A MLD for the repository is depicted in Figure 1 and is used as a reference to ensure that potentially seismically-initiated event sequences in all facilities are considered for dose to radiation workers and other onsite workers and public.

6.4.1.2 Seismic Event Tree Analysis

As in Section 6.3.1.2, simplified trees can be constructed to describe the series of events that must occur to result in a seismically-induced sequence that will result in a dose to the radiation worker. Figure 9 represents a seismically-induced loss of confinement resulting in an airborne dose to radiation workers in the operations area. Obviously, the extent of exposure is dependent on the type of waste form present and shielding present (OF_DSE), and if the worker can egress the area in sufficient time (OF_EGR) to mitigate the amount of exposure. This simplified SET is named AIR for reference in this analysis.

In a similar fashion, Figure 10 provides a simplified tree to describe the series of events that must occur to result in a radiation dose to radiation workers in the operations area due to a seismically-induced loss of shielding function. The shielding can be in the form of doors or view ports, which fail as well as the fracturing of the confinement walls, which can allow radiation exposure. This simplified SET is named RAD for reference in this analysis.

6.4.1.3 Fault Tree Analysis

For the present analyses, fault tree analyses are not developed for dose to radiation worker and others.

6.4.2 Dose Consequences of Seismic Event Sequences

At present, doses to radiation workers and others from possible event sequences described earlier are not available. However, since the shielding and other SSCs are installed to ensure that doses received during normal operations are acceptable, it is assumed that loss of the credited function in a seismically-initiated event sequence will exceed the allowable Category 1 dose limits for workers.

6.4.3 Assigning Design Basis Ground Motions to Structures, Systems, and Components Imporatnt to Safety

All SSCs ITS related to radiation worker dose and onsite public are to be assigned a DBGM-1 category. 10 CFR 63.111 does not specify worker dose for Category 2 event sequences. Therefore, if any SSC must be designated ITS to ensure meeting worker dose following an earthquake, the SSC is assigned to DBGM-1. However, some SSCs related to worker dose may be classified as DBGM-2 for other reasons. For example, a wall preventing worker dose may be classified as DBGM-2 for a safety function of no-collapse to comply with offsite dose requirements for offsite dose.

DBGM-1 level is defined at a 1×10^{-3} MAPE (Section 4.1.7). As the design matures and other SSCs are identified as ITS because of worker dose, such SSCs will be assigned a DBGM-1, as a minimum, according to the defined procedures in this analysis, as performed in Section 6.3.

Seismic Event Tree: AIR

EARTHQUAKE OCCURS	AIRLOCKS / PORTS FUNCTIONAL	WORKERS ARE NOT PRESENT AND BEING EXPOSED (RESIDENCY FACTOR)	RELEASE DOES NOT IMMEDIATELY EXCEED DOSE LIMITS	WORKERS CAN EGRESS (RESIDENCY FACTOR)	Sequence Number	Damage State	Dose to Worker Type
EQ	AIR_CELL	OF_WKR	OF_DSE	OF_EGR			
Initiating EQ	Success	N/A	N/A	N/A	1	OK	None
	Failure	Yes	N/A	N/A	2	OK	None
		No	Yes	Yes	3	Exposure	Mitigated
				No	4	Exposure	Unmitigated
			No	N/A	5	Exposure	Unmitigated

Figure 9. Simplified Seismic Event Tree for Loss of Confinement with Airborne Contaminants

Seismic Event Tree: RAD

EARTHQUAKE OCCURS	SHIELDING REMAINS FUNCTIONAL	WORKERS ARE NOT PRESENT AND BEING EXPOSED (RESIDENCY FACTOR)	RADIATION DOES NOT IMMEDIATELY EXCEED DOSE LIMITS	WORKERS CAN EGRESS (RESIDENCY FACTOR)	Sequence Number	Damage State	Dose to Worker Type
EQ	SHD_CELL	OF_WKR	OF_DSE	OF_EGR			
Initiating EQ	Success	N/A	N/A	N/A	1	OK	None
	Failure	Yes	N/A	N/A	2	OK	None
		No	Yes	Yes	3	Exposure	Mitigated
				No	4	Exposure	Unmitigated
			No	N/A	5	Exposure	Unmitigated

Figure 10. Simplified Seismic Event Tree for Loss of Shielding

6.5 SEISMIC INTERACTIONS AND SECONDARY FAILURES

6.5.1 Overview of Seismic Interactions

During the occurrence of an earthquake, it is possible for the seismic response of one SSC to affect the performance of another SSC. This sequence of events is called a seismic interaction, and often termed “two-over-one” interactions in nuclear power plant (NPP) seismic analyses. With regard to the current analysis, the potential for a secondary system to compromise the safety function of a SSC designated as DBGM-1 or DBGM-2 is evaluated.

Cases of seismic interaction include (e.g. DOE-STD-1020-2002, Appendix C):

- Structural failure and fall
- Proximity
- Flexibility of attached lines and cables
- Flooding or exposure to fluids from ruptured vessels and piping systems
- Effects of seismically-induced fires.

6.5.2 Structural Failure and Fall Interactions

Structural failure and fall can occur where a DBGM-1 or DBGM-2 designated SSC can potentially be damaged by an overhead or adjacent SSC with a lesser seismic designation. For example, the ducting or fan motors of a transfer cell ventilation system may fail as a result of an earthquake and strike a DOE canister. In another possible case, equipment supports might fail, allowing sampling devices or decontamination equipment to strike a CSNFA in a staging area.

To prevent such occurrences, SSCs that can cause this type of damage (the source SSCs) need to be identified. If a source SCC cannot be relocated or isolated using a barrier, additional seismic requirements need to be assigned to the source SSC to prevent the loss of safety function to the other (target) SSC. Therefore, depending on the dose consequences attributed to such an event sequence, a DBGM-1 level or a DBGM-2 level can be assigned to a SSC that is not ITS, if the response of the source SSC will affect the safety function of the target SSC.

At the present stage of design, there is insufficient detail to thoroughly address such event sequences, but an initial list is presented in Table 5. SSCs that are not ITS will be re-examined in updates to this analysis for possible seismically-initiated failure sequences. In addition, a proposed design requirement is identified to consider such interaction :

- System interaction that includes the adverse effects of failure of a lower seismic design category SSC on the safety function of a higher seismic design category SSC will be considered in the design.

Table 5. Potential Failure/Fall Seismic Interactions for Further Evaluation

System/Facility	Source SSC	Potential Interaction and Target SSC
DTF Wet Cask Remediation	20 ton overhead maintenance crane	Failure of crane into pool or onto other equipment including 200 ton handling crane
DTF Wet Cask Remediation	External walkway within area	Failure of walkway onto other SSCs or waste forms in pool
Transportation Cask Receipt/Return Facility	Walls of Warehouse and Non-Nuclear Receipt Facility (WNNRF)	Collapse on transportation casks of adjacent TCRRF Cask Receipt and Return Area
All	Anchorages above staging areas	Fall of SSC onto other SSCs

NOTE: DTF = Dry Transfer Facility; SSC = structure, system, or component; SSCs = structures, systems, and components; TCRRF = Transportation Cask Receipt/Return Facility.

6.5.3 Proximity Interactions

Impact between SSCs in close proximity to each other due to relative motion during earthquake response is another form of interaction, which must be considered in seismic interaction evaluations. If such an impact could cause damage or failure, a combined design approach of sufficient separation distance to prevent impact, and adequate anchorage, bracing, or other means to prevent large deflections, is typical. Of particular concern is the proximity of a waste handling facility directly adjacent to a non-waste handling facility such as a warehouse or administrative structure.

It should be noted that even if there is impact between adjacent structures and equipment, there may not be potential for any significant damage such that seismic interaction would not result in design measures being implemented. An example of such a case is a 1 in (0.03 m) diameter pipe, which cannot damage an adjacent 12 in (0.30 m) diameter pipe regardless of the separation distance.

An initial list of potential seismic interactions due to proximate SSCs is presented in Table 6. Similar to structural failure and fall interactions, SSCs that are not ITS will be re-examined in updates to this analysis for potential seismic interactions due to proximity.

Table 6. Potential Proximity Seismic Interactions for Further Evaluation

Source SSC	Target SSC	Potential Interaction
Warehouse and Non-Nuclear Receipt Facility (WNNRF)	Transportation Cask Receipt/Return Facility (TCRRF) Cask Receipt and Return Area	Source and target share common wall and many infrastructure systems
Firewater Facility (Central)	Fuel Handling Facility	Structural failure and water leakage/ water system failure
Slope	Initial Aging Facility	Failure of slope could affect pad stability

6.5.4 Flexibility Interactions

Another form of seismic interaction occurs where distribution lines such as piping, tubing, conduit, and cables connected to an item important to safety or production have insufficient flexibility to accommodate relative movement between the important item and adjacent structures or equipment to which the distribution line is anchored. This interaction may also involve the cable trays holding the cables.

To address this concern, the following proposed design requirement is identified:

- For SSCs identified as ITS and credited in the prevention or mitigation of seismically-initiated event sequences, sufficient flexibility of connected piping, tubing, conduit, and cables shall be provided from the important item to the first support on nearby structures or equipment. Failure of relevant cable trays shall also be considered in seismic design.

6.5.5 Flooding and Fire Interactions

Other forms of seismic interaction result if vessels or piping systems rupture due to earthquake excitation and cause fires or flooding that could affect performance of nearby important or critical SSCs. In this case, such vessels or piping systems must continue to perform their function of containing fluids or combustibles such that they shall be elevated in category to the level of the targets that would be endangered by their failure.

Possible seismically-initiated flooding and fire sequences were evaluated earlier as part of seismic hazard analysis and are identified in Attachment III. Potential seismically-initiated flooding sequences are identified in Table 7.

Table 7. Potential Flooding-Seismic Interactions for Further Evaluation

Source SSC [a]	**Target SSC** [a]	**Potential Interaction** [a]
DTF water lines of the high pressure water system used for decontamination activities in the WP/Trolley Decontamination Room	DTF WP Handling, Welding and Decontamination SSCs	Flooding of adjoining areas due to rupture of water line.
DTF water lines of the cask decontamination system or cask preparation system (cask cooling) in the cask wet remediation / lay down area.	DTF Wet Remediation SSCs	Flooding due to rupture of water line.
Water lines on the development side of the repository	WP Subsurface Transport and Emplacement SSC including WP, WP Transporter, Transport Locomotive	Flooding from a water pipe break.
Water lines on the development side of the repository	Subsurface Facilities SSCs	Flooding from a water pipe break.
Remediation Pool	DTF Wet Remediation SSCs Sump Area, Pool Cooling System	Flooding due to rupture or cracking of pool lining and rapid drawdown of pool.
Pool sump system (including pump, sump lines, seals and valves, etc).	DTF Wet Remediation SSCs Sump Area, Pool Cooling System	Flooding due to rupture of drainage line.

NOTE: [a] Source, target and potential interaction as identified in Attachment III.

DTF = Dry Transfer Facility; SSC = structure, system, or component; SSCs = structures, systems, and components; WP = waste package.

Regarding fires, seismically-induced fires can lead to the failure of cable systems, resulting in the loss of electrical circuits and power. These circuit failures in turn can lead to (a) the failure of remote and local control circuits; (b) the spurious actuation (chatter) of plant equipment; or (c) the actuation or shutdown of alarm and fire suppression systems (such as sprinklers). The actuation modes of circuit failures are typically assumed to be caused within a cable run by a ”hot short” (i.e., an electrical fault between cable conductors without a loss of conductor integrity or a simultaneous short to ground), and have been shown to be an important and sometimes even dominant contributor to fire risk in a number of NPP studies (NEA 2000, Section 2.2.2.2).

The potential for seismically-induced fires (and attendant control failures) together with flooding potential will be examined in updates to this analysis, as there is insufficient design information to evaluate these seismically-induced event sequences at this time.

6.6 EVALUATION OF THE HCLPF CAPACITIES OF STRUCTURES, SYSTEMS, AND COMPONENTS

A HCLPF capacity is tied to a specific seismic failure event or loss of a specific safety function for a given SSC. HCLPF capacities are developed by design engineering disciplines as input to the seismic systems analysis. When this analysis is performed, the HCLPF seismic margin for each SSC ITS will be computed and reported. The HCLPF seismic margin is the ratio of the HCLPF seismic capacity to the appropriate BDBGM ground motion acceleration. For conservatism, the HCLPF seismic margin will utilize a target minimum value of 1.10 (BSC 2004u, Section 3.3.2). In addition, in updates to this analysis, HCLPF capacities specific to designs of repository SSCs ITS will be calculated using the CDFM method (EPRI 1991, Chapter 2) or other accepted methods.

In this calculation, generic capacity factors are used to estimate representative HCLPF capacities (Section 5, Assumption 5.10), and HCLPF seismic margins are not computed. The HCLPF capacity defines the ground motion (e.g., PGA value) at which there is no more than 0.01 conditional probability of failure (loss of defined safety function). It is symbolized as $C_{0.01}$. In the CDFM method, it is shown that:

$$C_{0.01} \approx C_{CDFM} \tag{Eq. 1}$$

The CDFM capacity of any SSC can be estimated from:

$$C_{CDFM} = F_S * F_\mu * DBGM \tag{Eq. 2}$$

where DBGM is the design basis ground motion for which the SSC has been designed, F_S is a computed strength margin factor, and F_μ is an inelastic energy absorption factor (BSC 2004u, Appendix B). The DBGM is defined in terms of the PGA or spectral accelerations representative of design spectrum. For this analysis, it is assumed that the DBGM is specified by the PGA values presented in Table 1, Part A.

The product of strength margin factor and the inelastic energy absorption factor can be defined, for present purposes, as the HCLPF multiplier:

$$F_{HCLPF} = F_S * F_\mu \tag{Eq. 3}$$

The value of F_μ varies with the amount of structural deformation that is defined as representing "failure" for the loss of a given safety function. Table 8 presents definitions of Limits States A through D (BSC 2004u, Table A-1).

Table 8. Structural Deformation Limits for Limit States

Limit State	Structural Deformation Limit	Amount of Damage
A	Large permanent distortion, short of collapse	Significant
B	Moderate permanent distortion	Generally repairable
C	Limited permanent distortion	Minimal
D	Essentially elastic behavior	None

The term, $F_{S,}$ may be determined as the ratio of the 98 percent exceedance capacity over the seismic demand. This strength margin factor, $F_{S_{98\%}}$, can be written as (BSC 2004u, Appendix B, Eq. B-4):

$$F_{S_{98\%}} = \frac{F_C C_C - D_{NS}}{D_S} \quad \text{(Eq. 4)}$$

where C_C is the capacity computed using code and standard capacity acceptance criteria including strength-reduction factors permitted by code. D_{NS} is the expected concurrent, non-seismic demand, D_S is the conservatively estimated seismic demand computed for the DBGM input, and F_C is a capacity increase factor. The seismic demand, D_S, will be computed in accordance with applicable codes and standards.

The capacity increase factor, F_C, is given by:

$$F_C = \frac{C_{98\%}}{C_C} \quad \text{(Eq. 5)}$$

where $C_{98\%}$ is the estimated 98 percent exceedance probability capacity (BSC 2004u, Appendix B, Eq. B-5).

An approach for estimating $C_{98\%}$ is described in *A Methodology for Assessment of Nuclear Power Plant Seismic Margin* (EPRI 1991). When data are inadequate to estimate $C_{98\%}$ or for the sake of simplicity, F_C may conservatively be taken as 1.0.

As for typical values, median estimates of the various F_S values (i.e., $F_{S_{50\%}}$) have been shown to range between 1.2 and 2.5 (Kennedy and Ravindra 1984, Table 2). To estimate the corresponding F_S for $C_{98\%}$ values (i.e., $F_{S_{98\%}}$), a lognormal distribution is used relating $F_{S_{98\%}}$ and $F_{S_{50\%}}$, expressed as:

$$F_{S_{98\%}} = F_{S_{50\%}} e^{-2.054\beta_C} \quad \text{(Eq. 6)}$$

where β_C is the composite strength variability (Kennedy and Ravindra 1984, Eq. 4), which ranges from about 0.12 to 0.20 (Kennedy and Ravindra 1984, Table 3). The factor, 2.054, is from standardized Normal distribution percentiles. Using the stated range of β_C values, the exponential portion of Eq. 6 has values ranging from 0.6 and 0.8. Multiplying these values with the bounding values of 1.2 and 2.5 for $F_{S_{50\%}}$, a range for $F_{S_{98\%}}$ for typical structures is approximately:

$$F_{S_{98\%}} \approx 1 \text{ to } 2 \qquad \text{(Eq. 7)}$$

The $F_{S_{98\%}}$ value for low rise shear wall structures will be at the upper portion of this range, and for present purposes, $F_{S_{98\%}}$ is assumed to be 2.0, as shown in Table 9 (Assumption 5.10).

The inelastic energy absorption factor, F_μ, is to be estimated at the 95 percent exceedance probability (BSC 2004u, Appendix B, Section B-4.2). DOE-STD-1020-2002, Table 2-3, provides conservative generic estimates of 95 percent exceedance probability of F_μ for structures for Limit State C.

For example, the $F_\mu = 1.5$ value is given for concrete shear wall structures (in-plane shear) as a conservative generic estimate that reasonably corresponds to an allowable story drift limit of 0.4 percent, which is appropriate for Limit State C (BSC 2004u, Appendix B). The F_μ values are appropriately increased for Limit States A and B. Higher allowable drift limits of 0.75 percent and 0.6 percent are used for Limit States A and B, respectively (BSC 2004u, Appendix B). For low-rise shear walls, conservative generic inelastic energy absorption factors, F_μ, for Limit States A and B are estimated by increasing the Limit State C factor F_μ by slightly less than the square root of the ratio of allowable drift limits. The resulting F_μ values for low-rise shear walls are 2.0, 1.75, and 1.5 for Limit States A, B, and C, as shown in Table 9 (BSC 2004u, Appendix B).

Limit State A is defined as large permanent distortion. The HCLPF capacity for a collapse state is expected to be higher than for Limit State A. However, for this analysis, it is conservatively assumed that it is the same as the HCLPF capacity for Limit State A.

For this analysis, HCLPF capacities for mechanical and electrical equipment and anchorages specific to the repository are not available. For purposes of determining the overall HCLPF capacity for this analysis, HCLPF multiplier factors were estimated and are presented in Table 10 (Section 5, Assumption 5.10). To provide a comparison for this value, the median total equipment factor for mechanical components ranges from 3.5 to 20 in Kennedy and Ravindra (1984, Table 2), together with average β_C values ranging from about 0.4 to 0.7 (computed using Kennedy and Ravindra 1984, Eq. 4).

Again, using the normalized exponential relationship between the 99 percent curve and the median (e.g., Kennedy 2001, Eq. 4), the HCLPF multiplier factor at 99 percent $F_{HCLPF_{99\%}}$, is :

$$F_{HCLPF\ 99\%} = F_{HCLPF_{50\%}}\, e^{-2.326\beta_C} \tag{Eq. 8}$$

Where $F_{HCLPF_{50\%}}$ is the median value. For a β_C value of 0.5, the resultant range for capacity factor at 99 percent probability becomes 1 to 6. Using these values as a guide, an average value of 2.5 is assigned to active mechanical components, and 5.0 is assigned to passive mechanical components. A value of 3.0 for supports is roughly based on Kennedy and Ravindra (1984, Table 3) for Class 2 piping.

The HCLPF multipliers in Tables 9 and 10 are used to estimate the HCLPF capacities for SSCs as shown in Table 11. As design matures, actual HCLPF capacities appropriate to the design will be used.

Table 9. Capacity Calculations for Shear-Wall Structures

Type of SSCs	**Loss of Safety Function (Failure Criterion)**	**Structural Limit State** [a]	**Non-Linear Margin Factor** F_μ [b]	**Computed Strength Margin Factor** F_S	**HCLPF Multiplier for DBGM** $F_{HCLPF} = (F_\mu * F_S)$
Concrete Shear Wall	Collapse	**A** - Large permanent distortion	2.0	2.0	4.0
	Fail to support equipment	**B** - Moderate permanent distortion	1.75	2.0	3.5
	None, repairable	**C** - Limited permanent distortion	1.5	2.0	3.0

NOTE: [a] From BSC 2004u, Table A-1.

[b] F_μ is based on BSC (2004u, Appendix B); F_S is assumed (Assumption 5.10) and is comparable to data in Kennedy and Ravindra (1984, Table 2).

DBGM = design basis ground motion; HCLPF = high confidence of low probability of failure; SSCs = structures, systems, and components.

Table 10. Capacity Estimates for Mechanical Equipment

Type of SSCs	Loss of Safety Function (Failure Criterion)	HCLPF Multiplier for DBGM, F_{HCLPF} [a]
Supports (e.g., crane, fuel handling machine)	Fail to support equipment	3.0 [b]
Mechanical equipment (active component)	Fail to perform safety function	2.5 [b]
Mechanical equipment (passive components)	Fail to perform safety function	5.0 [b]

NOTES: [a] Multiplier is based on Limit State A, from Table 8. Specific values are estimates and will be replaced when values for actual equipment are available (Assumption 5.10).

[b] Value is assumed (Assumption 5.10) and is comparable to median fragility factors from Kennedy and Ravindra (1984, Table 3), reduced by a factor of 0.60.

[c] Value is assumed (Assumption 5.10) and is comparable to data in Kennedy and Ravindra (1984, Table 2). Note that the median values in cite need to be to converted to 99 percent percentile values to compare to assumption, i.e., the range of 3 to 20 is reduced to 1 to 6.

DBGM = design basis ground motion; HCLPF = high confidence of low probability of failure; SSCs = structures, systems, and components

Table 11. Representative High Confidence of Low Probability of Failure Capacities for Structure, Systems, and Components

Type of SSCs	Loss of Safety Function (Failure Criterion)	HCLPF Multiplier for DBGM	HCLPF Capacity (g)	
			Designed to DBGM-1 @ PGA = 0.37 g	Designed to DBGM-2 @ PGA = 0.58 g
Concrete Shear Wall	Collapse	4.0	1.48	2.32
	Fail to support equipment	3.5	1.30	2.03
	None, repairable	3.0	1.11	1.74
Supports (e.g., crane, fuel handling machine, or equipment)	Fail to support equipment	3.0	1.11	1.74
Mechanical Equipment	Fail to perform safety function, minimum (Active)	2.5	0.93	1.45
	Fail to perform safety function, maximum (Passive)	5.0	1.85	2.90

NOTE: Shaded data not used in analysis.

DBGM = design basis ground motion; HCLPF = high confidence of low probability of failure; PGA = peak ground acceleration; SSCs = structures, systems, and components.

6.7 REPOSITORY-WIDE HCLPF CAPACITIES

The analysis comprises the following activities:

- Develop Boolean expressions for the minimal cutsets of each credible seismic event sequence, which may include independent failure events as well as seismic failure events for various SSCs ITS. Cutsets that include independent failure events having a probability of less than 1×10^{-3} are screened out as described in Section II.4.4.

- Develop a repository-wide Boolean expression by combining the Boolean expression of individual credible sequences, and reduce it to its simplest form using Boolean algebra and screening criteria.

- Determine the repository-wide HCLPF capacity by inserting HCLPF capacities of seismic failure modes of SSCs ITS that appear in the repository-wide Boolean expression and then apply the min-max process.

Figure 11 illustrates the logic for developing the repository-wide Boolean expression for offsite dose.

The top event in Figure 11 is defined as "Seismic Failures Result in Dose ≥ 5 rem (or unknown)" and is developed as an OR-gate. One input to the top event is the event “DBGM-2

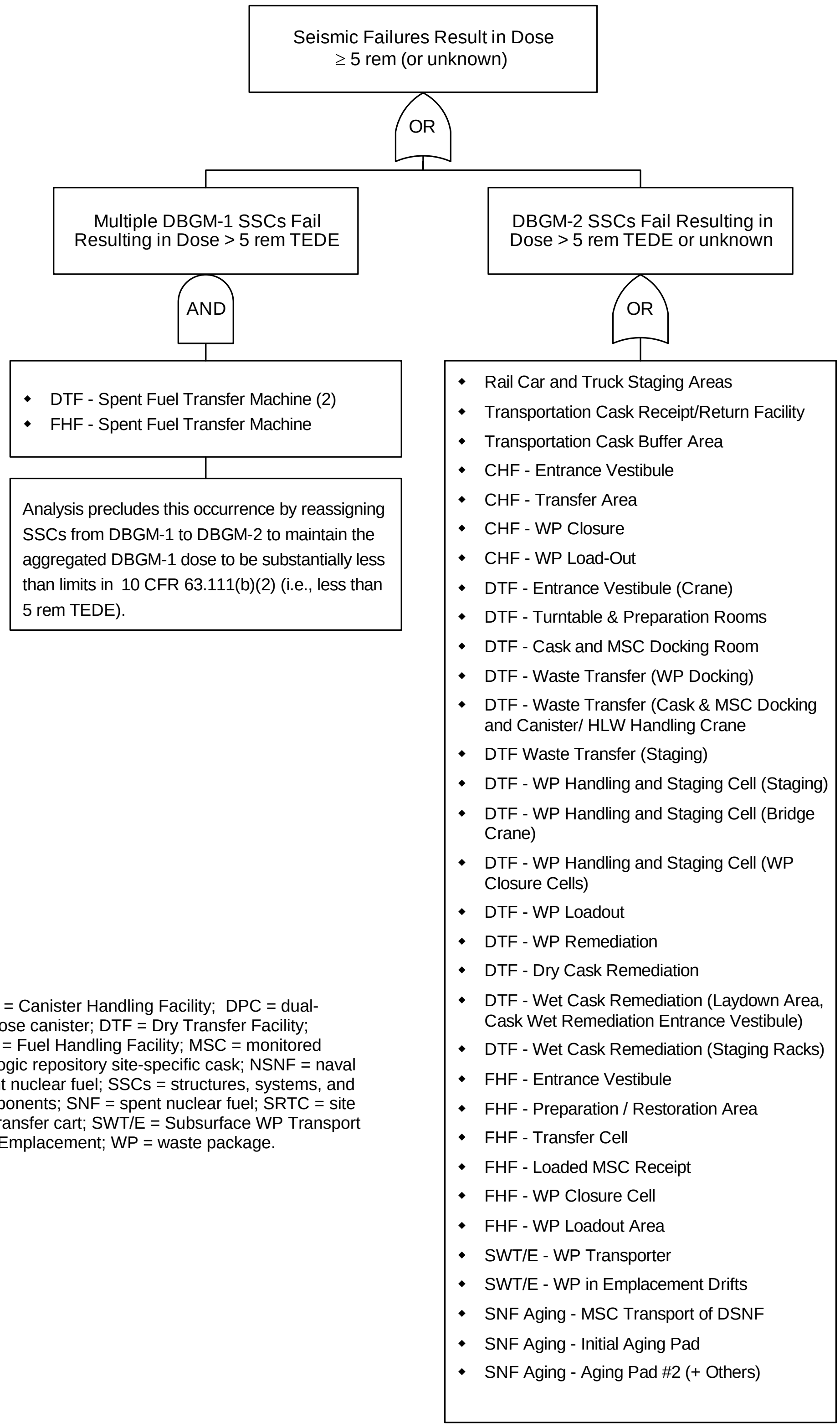
SSCs Fail Resulting in Dose ≥ 5 rem or Unknown." The phrase, "≥ 5 rem (or unknown)," refers to the dose resulting from breach of one or more DSNF canisters per Assumption 5.13. This event is developed as an OR-gate whose inputs are the failure events of DBGM-2 SSCs ITS in at least one of the functional areas listed in the box under the OR-gate. This part of the Boolean development is straightforward using the results of the event sequence consequence analysis and DBGM assignment.

The other input to the top event is "Multiple DBGM-1 SSC Fail Resulting in Dose ≥ 5 rem." This event is developed as an AND-gate; its inputs are the failure events of DBGM-1 SSCs in those functional areas listed in the box under the AND-gate whose combined doses equal or exceed 5 rem. However, as a result of the deterministic analysis and assigning DBGM-2 to SSCs that were initially assigned DBGM-1, there should be no combinations of failures of DBGM-1 SSCs that result in a dose ≥ 5 rem.

In the present analysis, therefore, the maximum dose from the concurrent failure of all DBGM-1 SSCs sums to 0.04 rem, as shown in Table 4. As a result, the seismic failure of DBGM-1 SSCs do not have to be included in the development of the overall Boolean expression for exceeding 5 rem.

In developing the present Boolean expressions, generic SET and FT analyses are applied. Unique identifying names are not used for basic events that refer to individual SSCs and specific seismically-induced loss of safety function. However, unique basis event names are used for seismic events pertaining to an entire facility. If the analyses were performed by computer, using a program such as SAPHIRE, it would be necessary to assign unique event names for each basic event representing a given seismically-induced failure for a specific SSC to avoid problems with the Boolean logic. When additional design detail and the need to perform seismic capacity analyses for specific SSCs, or complexity dictates the use of computer analyses, unique basic event identifiers will be developed. While similar event names are applied to several operational areas in the same facility, the distinction between seismic failures of specific SSCs in different functional areas is maintained in the structure of the tables used for the analysis. Generic SET models and event headings that appear in the generic SETs are used for the various surface facilities as illustrated in Table 12.

Table 12 lists the generic simplified SET models that apply to event sequences in each functional area. The names of the generic SETs are defined in Section 6.3.13. One column of Table 12 lists the SET models for direct seismic failures that are specific to operations in each functional area. This column includes one to three SET names for each functional area. The generic simplified SETs are assigned by inspection of the lists of potential seismically-induced event sequences shown in Table III-2 for each functional area.



NOTE: CHF = Canister Handling Facility; DPC = dual-purpose canister; DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; SSCs = structures, systems, and components; SNF = spent nuclear fuel; SRTC = site rail transfer cart; SWT/E = Subsurface WP Transport and Emplacement; WP = waste package.

Figure 11. Logic Diagram for Development of Facility-wide Boolean Expression for Dose to the Public

For example, wherever Table III-2 lists “collapse of structure,” the generic SET “COL” is applied. Similarly, wherever Table III-2 list “drop of cask” or “drop of fuel assembly,” etc., the generic SET “DSL” is applied. Similarly, the SET for “TOS” is assigned to tipovers and slap downs associated with SSCs that support or transport waste forms near to the ground. The SET “FHE” is applied wherever Table III-2 lists a drop of something other than a waste form. As noted, the present analysis does not include seismically-induced fire sequences.

Column five of Table 12 indicates which operations are susceptible to the seismic LOSP. This means that a LOSP SET is also applicable to that functional area. The Boolean expression for these functional areas must include both the direct and LOSP-related failure events.

Upon further consideration, it is judged that some of the event sequences can be screened out, and the SET names for those event sequences are enclosed in parentheses in the Operation Specific column. The bases for screening out these event sequences are given in the Comments column. In most instances, it is judged that the occupancy factor is small for these event sequences relative to other event sequences. Furthermore, the waste aging facility and WP storage in the emplacement drifts are screened out for reasons noted in the Comments column.

In lieu of generating numerous SETs, the generic simplified SETs are used by substituting unique names for operation-specific basic events. Table 13 lists the operation-specific event names, such as CHF_COLL_EQ in column 2, that are each used for several functional areas as listed in column 1. These operation-specific event names are categorized by the DBGM level and the generic HCLPF capacities are provided, based on the analyses described in Section 6.6.

Table 13 provides the operation-specific failure event names that correlate to the generic failure event names used in the SETs. Table 13 collects the various functional areas that use each simplified SET. Column 5 of Table 13 assigns a unique numerical identification tag to each functional area, within the same facility, that uses the same SET. Column 6 of Table 13 assigns unique basic event identifiers and unique event tree headings for each of the functional areas listed in Column 5. The operation-specific unique basic event names in Column 6 are used in the Boolean expressions for seismic event sequences in the various functional areas of the repository.

Table 14 presents the HCLPF capacities that are estimated for each of the basic events presented in Table 13. The HCLPF capacities in Table 14 are derived from the values presented in Table 11 according to the DBGM assignment developed in Table 12 for SSCs in each functional area.

The simplified generic event trees and fault trees associated with the event headings, along with operation-specific basic event names, are used to determine the minimal cutsets for the seismic event sequences for each functional area. Each minimal cutset contains one or more failure events that can result in the undesired event sequence. The union (OR logic) of all minimal cutsets for all undesired event sequence(s) of each functional area gives the Boolean expression for that functional area.

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences

Functional Area and SSCs [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	Subject to LOSP	
Transportation Facility					
Railcar Staging Area	Transportation Cask	DBGM-2	[TOS]	No	Low occupancy factor as transportation casks retain impact limiters prior to move to other facilities.
Truck Staging Area	Transportation Cask	DBGM-2	[TOS]	No	Low occupancy factor as transportation casks retain impact limiters prior to move to other facilities.
Receipt Systems					
Cask and Waste Package Receipt Building - Transportation Cask Receipt/Return Facility	Transportation Cask	DBGM-2	[TOS]	No	Low occupancy factor as only small fraction of transportation casks have impact limiters removed prior to movement into other facility.
Transportation Cask Buffer Area	Transportation Cask	DBGM-2	[TOS]	No	Low occupancy factor as only small fraction of transportation casks have impact limiters removed prior to movement into other facility.

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences (Continued)

Functional Area [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	Subject to LOSP	
Canister Handling Facility					
Entrance Vestibule	Transportation Cask	DBGM-2	TOS	Yes	
Transfer Area - Handling	Transportation Cask	DBGM-2	TOS [+ DSL + FHE]	Yes	Small occupancy factor for DSL, FHE, and LOSP.
Transfer Area - Pits (MSC)	MSC	DBGM-2	COL + DSL + FHE	Yes	
Transfer Area - Pits (Canister)	WP	DBGM-2	DSL + FHE	Yes	
Transfer Area - Staging Pits	Canister (DSNF)	DBGM-2	COL + RC	No	
WP Closure	WP	DBGM-2	TOS + FHE [+ DSL]	Yes	Small occupancy factor for DSL.
WP Transporter Load	WP	DBGM-2	COL + FHE	Yes	
Dry Transfer Facility (2)					
Entrance Vestibule - 200 ton Cask Handling Crane	Transportation Cask	DBGM-2	COL + DSL	Yes	
Entrance Vestibule - SRTC	MSC	DBGM-2	TOS	Yes	
Turntable and Preparation Rooms	Transportation Cask	DBGM-2	COL + TOS [+ FHE]	Yes	Small occupancy factor for FHE.
Cask and MSC Docking Room	Transportation Cask	DBGM-2	COL + TOS [+ FHE]	Yes	Small occupancy factor for FHE.
NSNF Receipt - 200 ton Navy Cask Handling Crane	NSNF	DBGM-2	COL + DSL	Yes	

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences (Continued)

Functional Area [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	Subject to LOSP	
NSNF Processing - 70 ton Navy Cask Handling Crane	NSNF	DBGM-2	COL + DSL	Yes	
Waste Transfer - WP Docking	WP (CSNFA - 21 PWR) (2) or WP (Canister) (2)	DBGM-2	COL + FHE [+ DSL]	Yes	Small occupancy factor for DSL.
Waste Transfer - Spent Fuel Transfer Machine	CSNF	DBGM-1	DSL	Yes	
Waste Transfer - Cask and MSC Docking	Transportation Cask (2) or MSC (2)	DBGM-2	COL + FHE [+ DSL]	Yes	Small occupancy factor for DSL.
Waste Transfer - Staging (CSNF)	CSNF	DBGM-2	COL + RC	No	(Note: Re-assigned to DBGM-2 in Table 4)
Waste Transfer - Staging (Canisters)	Canisters (Including DSNF)	DBGM-2	COL [+ RC]	No	Rack collapse does not exceed equivalent design lift height.
Cask Restoration Room/ Loaded MSC Removal	MSC	DBGM-2	COL + TOS	Yes	
WP Handling and Staging Cell - Staging	WP	DBGM-2	COL + TOS	Yes	
WP Handling and Staging Cell - Bridge Crane	WP	DBGM-2	DSL	Yes	
WP Handling and Staging Cell - WP Closure Cells	WP	DBGM-2	COL + TOS [+ FHE]	Yes	Small occupancy factor for FHE.
WP Loadout	WP	DBGM-2	COL + FHE	Yes	

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences (Continued)

Functional Area [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	**Subject to LOSP**	
WP Remediation	WP	DBGM-2	COL [+ FHE + DSL]	Yes	Small occupancy factor for FHE, DSL, and LOSP due to infrequent use of Remediation Building.
Dry Cask Remediation	MSC or Transportation Cask or SNF/HLW DPC	DBGM-2	COL [+ FHE + DSL]	Yes	Small occupancy factor for FHE, DSL, and LOSP due to infrequent use of Remediation Building.
Wet Cask Remediation	Transportation Cask, MSC, DSNF/HLW Canisters, NSNF, Special Canister	DBGM-2	COL [+ FHE + DSL]	Yes	Small occupancy factor for FHE, DSL, and LOSP due to infrequent use of Remediation Building.
Wet Cask Remediation - Staging Racks	PWR CSNFA, BWR CSNFA, and DSNF	DBGM-2	COL + RC	No	
DPC Cutting	DPC	DBGM-2	TOS + FHE [+ DSL]	Yes	Small occupancy factor for DSL. (Note: Re-assigned to DBGM-2)
Fuel Handling Facility					
Entrance Vestibule	Transportation Cask	DBGM-2	COL + TOS	Yes	
Preparation/Restoration Area	Transportation Cask	DBGM-2	COL + TOS [+ DSL + FHE]	Yes	Small occupancy factor for DSL, FHE, and LOSP
Transfer Cell	Transportation Cask	DBGM-2	DSL + TOS	Yes	
Transfer Cell - Pit	MSC	DBGM-2	FHE	No	
Transfer Cell - Pit	WP	DBGM-2	FHE	No	

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences (Continued)

Functional Area [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	Subject to LOSP	
Waste Transfer - Spent Fuel Transfer Machine	CSNF	DBGM-1	DSL	Yes	
Loaded MSC Receipt	WP	DBGM-2	DSL + FHE	Yes	
WP Closure Cell	WP	DBGM-2	TOS + FHE [+ DSL]	Yes	Small occupancy factor for DSL.
WP Loadout Area	WP	DBGM-2	COL + FHE	Yes	
Subsurface WP Transport/Emplacement					
WP Transporter	WP(CSNFA and Canister)	DBGM-2	[Not Analyzed]	No	Transporter is self-powered. Transporter drive stops on loss of power and operator can intervene, as necessary, to recover from seismically-induced spurious operations. Small occupancy factor for downgrade. Derailment due to invert or track distortions does not cause impacts beyond WP design bases.
WP in Emplacement Drifts	WP	DBGM-2	[Not Analyzed]	No	WP is designed not to breach for seismic motions or impact of falling rock and support due to DBGM-2.
SNF Aging Facility					
Transporters	MSC per trip	DBGM-1	TOS	No	Transporter is self-powered.
	DPC per trip	DBGM-1	TOS	No	Transporter is self-powered.
	DSNF (per trip)	DBGM-2	TOS	No	Transporter is self-powered.
Initial Aging Pad	Aging Module - Horizontal	DBGM-2	[TOS]	No	Design to sustain DBGM-2 event without tipover or slap down of canister.
Initial Aging Pad	Aging Module - Vertical	DBGM-2	[TOS]	No	Design to sustain DBGM-2 event without tipover or slap down of canister.

Table 12. Seismic Event Trees and Events Associated with Seismic Event Sequences (Continued)

Functional Area [a]	Waste Form [a]	DBGM Group [a]	Generic SET Model		Comment
			Operation Specific [b,c]	Subject to LOSP	
Aging Pad #2 (+ Others)	Aging Module - Horizontal	DBGM-2	[TOS]	No	Design to sustain DBGM-2 event without tipover or slap down of canister.
Aging Pad #2 (+ Others)	Aging Module - Vertical	DBGM-2	[TOS]	No	Design to sustain DBGM-2 event without tipover or slap down of canister.

NOTES: [a.] From Table 4.

[b.] Section 6.3.1.2 provides definitions of simplified event trees.

[c.] Items in parentheses are screened out from further consideration per rationale in the Comments column.

CSNFA = commercial spent nuclear fuel assembly; DBGM = design basis ground motion; DPC = dual-purpose canister; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; PWR = pressurized water reactor; RC = Rack collapse; SRTC = site rail transfer cart; WP = waste package.

Table 13. Operation-Specific Failure Event Name Used with Generic Seismic Event Tree

Generic Set [a]	Failure Event Name in Generic [b]	Failure Event Definition	Functional Area	Operation-Specific Failure Event Name [c]
COL	CELL_COLL	Collapse of Transfer Cell or Other Structure	CHF Transfer Area - Pits (MSC) CHF Transfer Area - Pits (Canister) CHF Transfer Area - Staging Pits CHF WP Transporter Load	CHF_COLL_EQ
			DTF Entrance Vestibule - 200 ton Cask Handling Crane DTF NSNF Receipt - 200 ton Navy Cask Handling Crane DTF NSNF Processing - 70 ton Navy Cask Handling Crane DTF Turntable and Preparation Rooms DTF Cask and MSC Docking Room DTF NSNF Receipt DTF NSNF Processing DTF - Waste Transfer - WP Docking DTF Waste Transfer - Cask & MSC Docking DTF Waste Transfer - Staging (CSNF) DTF Waste Transfer - Staging (Canisters) DTF Cask Restoration Room/Loaded MSC Removal DTF WP Handling and Staging Cell - Staging DTF WP Handling and Staging Cell - WP Closure Cells DTF WP Loadout DTF WP Remediation DTF Dry Cask Remediation DTF Wet Cask Remediation DTF Wet Cask Remediation - Staging Racks	DTF_COLL_EQ
			FHF Entrance Vestibule FHF Preparation / Restoration Area FHF WP Loadout Area	FHF_COLL_EQ

Table 13. Operation-Specific Failure Event Name Used with Generic Seismic Event Tree (Continued)

Generic SET [a]	Failure Event Name in Generic [b]	Failure Event Definition	Functional Area	Operation-Specific Failure Event Name [c]
DSL	EQPT_SUP	See FHE	See FHE	See FHE
	DR_LOAD	Failure of Crane or Fuel Handling Machine to Maintain Load	CHF Transfer Area - Handling (Crane)	DR_LOAD_CHF [CHF_LH_EQ + CHF_CONLH_EQ]
			DTF Entrance Vestibule (200 ton Cask Handling Crane)	DR_LOAD_DTC [DTC_LH_EQ + DTC_CONLH_EQ]
			DTF NSNF Receipt - 200 ton Navy Cask Handling Crane	
			DTF NSNF Processing - 70 ton Navy Cask Handling Crane	
			DTF WP Handling and Staging Cell - Bridge Crane	
			DTF Waste Transfer - Spent Fuel Transfer Machine	DR_LOAD_FHM [FHM_LH_EQ + FHM_CONLH_EQ]
			FHF Waste Transfer - Spent Fuel Transfer Machine	
			FHF Transfer Cell (Crane)	DR_LOAD_FHF [FHF_LH_EQ + FHF_CONLH_EQ]
			FHF Loaded MSC Receipt	
FHE	EQPT_SUP	Failure of Support Structure of Crane or Fuel Handling Machine (Spent Fuel Transfer Machine)	CHF Transfer Area - Pits (MSC)	CHF_EQSUP_EQ
			CHF Transfer Area - Pits (Canister)	
			CHF WP Closure	
			CHF WP Transporter Load	
			DTF Waste Transfer - Spent Fuel Transfer Machine	FHM_EQSUP_EQ

Table 13. Operation-Specific Failure Event Name Used with Generic Seismic Event Tree (Continued)

Generic SET [a]	Failure Event Name in Generic [b]	Failure Event Definition	Functional Area	Operation-Specific Failure Event Name [c]
FHE (Continued)			DTF Waste Transfer - WP Docking	DTF_EQSUP_EQ
			DTF Waste Transfer - Cask & MSC Docking	
			DTF WP Loadout	
			DTF DPC Cutting	DPCC_EQSUP_EQ
			FHF Transfer Cell - Pit	FHF_EQSUP_EQ
			FHF Loaded MSC Receipt	
			FHF WP Closure Cell	
			FHF WP Loadout Area	
LOSP	LOSP	Loss of Offsite Power	All active SSCs except battery powered	LOSP_EQ (for all)
	EQT_FS	Failure of Handling Equipment to Stop in Fail-Safe Mode	DTF Entrance Vestibule - 200 ton Cask Handling Crane	EQT_FS_DTC [DTC_FS_EQ]
			DTF NSNF Receipt - 200 ton Navy Cask Handling Crane	
			DTF NSNF Processing - 70 ton Navy Cask Handling Crane	
			DTF Waste Transfer - Spent Fuel Transfer Machine	EQT_FS_FHM [FHM_FS_EQ]
			DTF WP Handling and Staging Cell - Bridge Crane	EQT_FS_DHC [DHC_FS_EQ]
			FHF Transfer Cell (Crane)	EQT_FS_FHC [FHC_FS_EQ]

Table 13. Operation-Specific Failure Event Name Used with Generic Seismic Event Tree (Continued)

Generic SET [a]	Failure Event Name in Generic [b]	Failure Event Definition	Functional Area	Operation-Specific Failure Event Name [c]
TOS	TROL_TO	Trolley, Lorry, or Fixture Tipover, Slap Down or Impact	CHF Entrance Vestibule	TRCSK_FIXT_EQ
			CHF Transfer Area - Handling	CHF_FIXT_EQ
			CHF WP Closure	CHF_FIXT_EQ
			DTF Entrance Vestibule - SRTC	TRCSK_FIXT_EQ
			DTF Turntable & Preparation Rooms	DTF_FIXT_EQ
			DTF Cask and MSC Docking Room	DTF_FIXT_EQ
			DTF NSNF Processing	DTN_FIXT_EQ
			DTF Cask Restoration Room/Loaded MSC Removal	DTN_FIXT_EQ
			DTF WP Handling and Staging Cell - Staging	DTS_FIXT_EQ
			DTF WP Handling and Staging Cell - WP Closure Cells	DTS_FIXT_EQ
			DTF DPC Cutting	DPC_FIXT_EQ
			FHF Entrance Vestibule	FHE_FIXT_EQ
			FHF Preparation/Restoration Area	FHP_FIXT_EQ
			FHF Transfer Cell	TRCSK_FIXT_EQ
			FHF WP Closure Cell	FHC_FIXT_EQ
			WP Subsurface Transport and Emplacement - WP Transporter	SSC_TRAN_EQ

Table 13. Operation-Specific Failure Event Name Used with Generic Seismic Event Tree (Continued)

Generic SET [a]	Failure Event Name in Generic [b]	Failure Event Definition	Functional Area	Operation-Specific Failure Event Name [c]
TOS (Continued)	TROL_TO (Continued)	(see prior page)	SNF Aging Facility Transporters	SMSC_TRAN_EQ
			MSC Transporter	MSC_TRANS_EQ
RC	Not illustrated	CSNFA Staging Racks Collapse Due To Earthquake	CHF Transfer Area - Staging Pits	CHF_RCK_EQ
			DTF Waste Transfer - Staging (CSNF)	DTF_RCK_EQ
			DTF Wet Cask Remediation - Staging Racks (PWR CSNFA)	RBP_RCK_EQ
			DTF Wet Cask Remediation - Staging Racks (BWR CSNFA)	RBB_RCK_EQ

NOTES: [a] Defined in Table 12.

[b] Defined in Attachment V.

[c] Developed from fault tree; SET failure event replaced by basic event names for top event of supporting fault tree.

BWR = boiling water reactor; CHF = Canister Handling Facility; CSNFA = commercial spent nuclear fuel assembly; DPC = dual-purpose canister; DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; PWR = pressurized water reactor; RC = rack collapse; SET = seismic event tree; SSCs = structures, systems, and components; SNF = spent nuclear fuel; SRTC = site rail transfer cart; WP = waste package.

Table 15 lists the Boolean expressions for the event sequences associated with failures of DBGM-1 SSCs. Table 16 lists the Boolean expressions for the event sequences associated with failures of DBGM-2 SSCs. The Boolean expressions for many functional areas are reduced to one cutset containing one seismic failure event. The same basic event may appear in the Boolean expressions for two or more event sequences. If so, the rules of Boolean algebra are applied to absorb the multiple occurrences in the Boolean expression for the combination of event sequences.

Tables 12 and 13 are used to generate the HCLPF capacity for the repository using the min-max process. First, HCLPF capacities for each SSC failure event are entered into the "Event HCLPF Capacities" columns of Tables 12 and 13. The min-max logic is applied, as appropriate, to the Boolean expression for each functional area to determine the limiting HCLPF capacity for failure events associated with each.

Figure 11 indicates that event sequences involving DBGM-1 SSCs must be combined with AND logic to produce a dose that could exceed 5 rem TEDE. After re-assignment of some functional areas and their associated SSCs to DBGM-2, the sum of doses from the remaining DBGM-1 SSCs is only 0.04 rem (recorded in Table 14). Therefore, the seismic events from the AND gate do not contribute to the evaluation of the overall Boolean expression for exceeding 5 rem. This does not preclude a large seismic event (i.e., larger then DBGM-1, but less than DBGM-2) that would fail all DBGM-1 SSCs, resulting in an offsite dose of 0.04 rem.

Table 15 indicates that the <u>minimum</u> HCLPF capacity for DBGM-1 SSCs is 0.93 g. This represents the level of ground motion at which there is about a 1 percent chance that at least one SSC would fail and potentially result in an offsite dose greater than 15 mrem (but less than 5 rem) at the site boundary (or exceed other DBGM-1 dose limits).

However, the AND analysis of seismic failures of DBGM-1 SSCs provides a Boolean expression for evaluating the HCLPF capacity for contributing toward doses that exceed the 5 rem limit for Category 2 event sequences, when combined with the seismic failure of one or more DBGM-2 SSCs. Therefore, the <u>net</u> HCLPF capacity for the combined event sequences in Table 15 is the maximum of the HCLPF capacities of the DBGM-1 SSCs for the event sequences of the individual functional areas. This HCLPF represents the peak ground motion at which there is a probability of 0.01 (or less) of having an offsite dose of 0.04 rem. This result is 0.93 g.

Figure 11 also indicates that event sequences involving DBGM-2 SSCs must be combined with OR logic. Therefore, the HCLPF capacity for the combined event sequences in Table 16 is the minimum of the HCLPF capacities of the SSCs for the event sequences of the individual functional areas. This result shown is 1.45 g.

Table 14. Basic Event Names and Estimated HCLPF Capacities

Functional Area [a]	**Operation-Specific Failure Event Name**	**Category Of SSCs For Representative HCLPF Capacity**	**Loss Of Safety Function** [b]	**HCLPF Capacity - DBGM-1 (g)** [b]	**HCLPF Capacity- DBGM-2 (g)** [b]
CHF Transfer Area - Pits CHF Transfer Area - Staging Pits CHF WP Transporter Load	CHF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
DTF Entrance Vestibule - Crane DTF Turntable and Preparation Rooms DTF Cask and MSC Docking Room DTF - Waste Transfer - WP Docking DTF Waste Transfer - Cask and MSC Docking DTF Waste Transfer - Staging (CSNF) DTF Waste Transfer - Staging (Canisters) DTF WP Handling and Staging Cell - Staging DTF WP Handling and Staging Cell - WP Closure Cells DTF WP Loadout	DTF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
DTF NSNF Receipt - 70 ton Navy Cask Handling Crane DTF NSNF Processing - 200 ton Navy Cask Handling Crane	DTF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
DTF Cask Restoration Room/Loaded MSC Removal	DTF_COLL_EQ	Concrete Shear Wall	Collapse	1.48	---
DTF Waste Transfer - Staging (CSNF)	DTF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
DTF WP Remediation DTF Dry Remediation	DTF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	Operation-Specific Failure Event Name	Category Of SSCs For Representative HCLPF Capacity	Loss Of Safety Function [b]	HCLPF Capacity - DBGM-1 (g) [b]	HCLPF Capacity- DBGM-2 (g)[b]
DTF Wet Remediation DTF Wet Remediation - Staging Racks	DTF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
FHF Entrance Vestibule FHF Preparation/Restoration Area FHF WP Loadout Area	FHF_COLL_EQ	Concrete Shear Wall	Collapse	---	2.32
CHF Transfer Area - Handling (Crane)	DR_LOAD_CHF [CHF_LH_EQ + CHF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
DTF NSNF Receipt - 200 ton Navy Cask Handling Crane DTF NSNF Processing - 70 ton Navy Cask Handling Crane	DR_LOAD_DTC [b] [DTF_LH_EQ + DTF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
DTF Entrance Vestibule (200 ton Cask Handling Crane) DTF WP Handling and Staging Cell - Bridge Crane	DR_LOAD_DTC [b] [DTF_LH_EQ + DTF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
DTF Waste Transfer - Spent Fuel Transfer Machine	DR_LOAD_FHM [b] [DTF_LH_EQ + DTF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	0.93	---
FHF Waste Transfer - Spent Fuel Transfer Machine	DR_LOAD_FHM [b] [DTF_LH_EQ + DTF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	0.93	---
FHF Transfer Cell (Crane) FHF Loaded MSC Receipt	DR_LOAD_FHF [FHF_LH_EQ + FHF_CONLM_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	Operation-Specific Failure Event Name	Category Of SSCs For Representative HCLPF Capacity	Loss Of Safety Function [b]	HCLPF Capacity - DBGM-1 (g) [b]	HCLPF Capacity- DBGM-2 (g)[b]
CHF Transfer Area - Pits (Canister)	CHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
CHF Transfer Area - Pits (MSC)	CHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
CHF WP Closure	CHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
CHF WP Transporter Load	CHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
DTF Waste Transfer - Spent Fuel Transfer Machine	FHM_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
DTF Waste Transfer - WP Docking	DTF_CRSUP_EQ	Supports	Failure to support equipment	---	1.74
DTF Waste Transfer - Cask and MSC Docking	DTF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
DTF WP Loadout	DTF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
DTF DPC Cutting	DPCC_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
FHF Transfer Cell - Pit	FHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	Operation-Specific Failure Event Name	Category Of SSCs For Representative HCLPF Capacity	Loss Of Safety Function [b]	HCLPF Capacity - DBGM-1 (g) [b]	HCLPF Capacity- DBGM-2 (g) [b]
FHF Loaded MSC Receipt	FHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
FHF WP Closure Cell	FHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
FHF WP Loadout Area	FHF_EQSUP_EQ	Supports	Failure to support equipment	---	1.74
LOSP	LOSP_EQ (for all)	Ceramic Insulators	Loss of power to cranes and handling equipment	0.10	0.10
DTF Entrance Vestibule - 200 ton Cask Handling Crane	EQT_FS_DTC [DTF_FS_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
DTF NSNF Receipt - 200 ton Navy Cask Handling Crane - Receipt	EQT_FS_DTC [DTF_FS_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)		1.45
DTF NSNF Processing - 70 ton Navy Cask Handling Crane - Processing	EQT_FS_DTC [DTF_FS_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)		1.45
DTF Waste Transfer - Spent Fuel Transfer Machine	EQT_FS_FHM [DTF_FS_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	0.93	---

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	**Operation-Specific Failure Event Name**	**Category Of SSCs For Representative HCLPF Capacity**	**Loss Of Safety Function** [b]	**HCLPF Capacity - DBGM-1 (g)** [b]	**HCLPF Capacity-DBGM-2 (g)**[b]
DTF WP Handling and Staging Cell - Bridge Crane	EQT_FS_DHC [FHF_FS_EQ]	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
FHF Transfer Cell (Crane)	EQT_FS_FHC	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
CHF Entrance Vestibule	TRCSK_FIXT_EQ	Supports	Fail to support equipment	---	1.74
CHF Transfer Area - Handling	CHF_FIXT_EQ	Supports	Fail to support equipment	---	1.74
CHF WP Closure	CHF_FIXT_EQ	Supports	Fail to support equipment	---	1.74
DTF Entrance Vestibule - SRTC	TRCSK_FIXT_EQ	Mechanical Equipment	Fail to perform safety function, minimum (Active)	---	1.45
DTF Turntable & Preparation Rooms	DTF_FIXT_EQ	Supports	Failure to support equipment	---	1.74
DTF Cask and MSC Docking Room	DTF_FIXT_EQ	Supports	Failure to support equipment	---	1.74
DTF NSNF Processing	DTN_FIXT_EQ	Supports	Failure to support equipment	---	1.74
DTF Cask Restoration Room/Loaded MSC Removal	DTN_FIXT_EQ	Supports	Failure to support equipment	---	1.74

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	Operation-Specific Failure Event Name	Category Of SSCs For Representative HCLPF Capacity	Loss Of Safety Function [b]	HCLPF Capacity - DBGM-1 (g) [b]	HCLPF Capacity-DBGM-2 (g)[b]
DTF WP Handling and Staging Cell - Staging	DTS_FIXT_EQ	Supports	Failure to support equipment	---	1.74
DTF WP Handling and Staging Cell - WP Closure Cells	DTS_FIXT_EQ	Supports	Failure to support equipment	---	1.74
DTF DPC Cutting	DPC_FIXT_EQ	Supports	Failure to support equipment	---	1.74
FHF Entrance Vestibule	FHE_FIXT_EQ	Supports	Failure to support equipment	---	1.74
FHF Preparation/Restoration Area	FHP_FIXT_EQ	Supports	Failure to support equipment	---	1.74
FHF Transfer Cell	TRCSK_FIXT_EQ	Supports	Failure to support equipment	---	1.74
FHF WP Closure Cell	FHC_FIXT_EQ	Supports	Failure to support equipment	---	1.74
WP Subsurface Transport and Emplacement - WP Transporter	SSC_TRAN_EQ	Mechanical Equipment (On-board electromechanical)	Fail to perform safety function, minimum (Active)	---	1.45
MSC Transport (MSC/DPC/DSNF)	MSC_TRAN_EQ	Mechanical Equipment (On-board electromechanical)	Fail to perform safety function, minimum (Active)	---	1.45

Table 14. Basic Event Names and Estimated HCLPF Capacities (Continued)

Functional Area [a]	**Operation-Specific Failure Event Name**	**Category Of SSCs For Representative HCLPF Capacity**	**Loss Of Safety Function** [b]	**HCLPF Capacity - DBGM-1 (g)** [b]	**HCLPF Capacity- DBGM-2 (g)**[b]
SNF Aging Facility MSC Transport	SMSC_TRAN_EQ	Mechanical Equipment (On-board electromechanical)	Fail to perform safety function, minimum (Active)	---	1.45
CHF Transfer Area - Staging Pits	CHF_RCK_EQ	Mechanical Equipment (Mid-range, passive)	Fail to perform safety function, maximum (Passive)	---	2.90
DTF Waste Transfer - Staging (CSNF)	DTF_RCK_EQ	Mechanical Equipment (Mid-range, passive)	Fail to perform safety function, maximum (Passive)	---	2.90
DTF Wet Cask Remediation - Staging Racks (PWR or BWR CSNFA)	RBP_RCK_EQ	Mechanical Equipment (Mid-range, passive)	Fail to perform safety function, maximum (Passive)	---	2.90

NOTES: [a] From Table 4.

[b] HCLPF capacities of SSCs and defined safety functions are based on Table 11.

BWR = boiling water reactor; CHF = Canister Handling Facility; CSNF = commercial spent nuclear fuel; DBGM = design basis ground motion; DPC = dual-purpose canister; DSNF = U.S. Department of Energy-owned spent nuclear fuel; DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; HCLPF = high confidence of low probability of failure; LOSP = loss of offsite power; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; PWR = pressurized water reactor; SNF = spent nuclear fuel; SNF = spent nuclear fuel; SRTC = site rail transfer cart; WP = waste package.

Table 15. Boolean Expression and HCLPF Capacity Evaluation for Event Sequences Involving DBGM-1 Structures, Systems, and Components

Functional Area	Offsite Dose (rem) [a]	SET Model	Boolean Expression for Event Sequence	HCLPF Capacity Calculation for Sequence Boolean (g) [b]	HCLPF Capacity for Sequence (g) [c]
DTF Waste Transfer - Spent Fuel Transfer Machine	0.03	DSL	DR_LOAD_FHM	0.93	0.93
FHF Waste Transfer - Spent Fuel Transfer Machine	0.01	DSL	DR_LOAD_FHM	0.93	0.93
Total Dose from the loss of Safety Function for DBGM-1 SSCs [c]	**0.04**				
		Net HCLPF for DBGM-1 event sequences: {max} [c] =			**{0.93}**
		Minimum HCLPF for Any DBGM-1 event sequences: {min} [c] =			**{0.93}**

NOTES: [a] See Table 4 for source of dose values, and Table 14 for HCLPF capacities.

[b] Boolean expressions for DBGM-1 use min{} or max{} logic as shown.

[c] HCLPF capacity for the seismic failure of all DBGM-1 SSCs is the maximum HCLPF capacity of individual SSCs. The HCLPF capacity for seismic failure of any single DBGM-1 SSC is the minimum HCLPF capacity of individual SSCs.

CSNF = commercial spent nuclear fuel; DBGM = design basis ground motion; DPC = dual-purpose canister; DTF = Dry Transfer Facility; HCLPF = high probability of low probability of failure; MSC = monitored geologic repository site-specific cask; NSNF = naval spent nuclear fuel; SRTC = site rail transfer cart; SSCs = structures, systems, and components.

Table 16. Boolean Expression and HCLPF Capacity Evaluation for Event Sequences Involving DBGM-2 Structures, Systems, and Components

Functional Area [a]	**Offsite Dose (rem)** [a]	**SET Model** [b]	**Boolean Expression for Event Sequence**	**HCLPF Capacity Calculation for Sequence Boolean (g)** [a,d]	**HCLPF Capacity for Sequence (g)** [c]
CHF Entrance Vestibule	> 5	TOS	TRCSK_FIXT_EQ	1.74	1.74
CHF Transfer Area - Handling	> 5	TOS	CHF_FIXT_EQ	1.74	1.74
CHF Transfer Area - Pits (MSC)	> 5	COL + FHE	CHF_COLL_EQ + CHF_EQSUP_EQ	min{2.32, 1.74}	1.74
CHF Transfer Area - Pits (Canister)	> 5	COL + FHE	CHF_COLL_EQ + CHF_EQSUP_EQ	min{2.32, 1.74 }	1.74
CHF Transfer Area - Staging Pits	> 5	COL + RC	CHF_COLL_EQ + CHF_RCK_EQ	min{2.32, 2.90}	2.32
CHF WP Closure	> 5	TOS + FHE	CHF_FIXT_EQ + CHF_EQSUP_EQ	min{1.74, 1.74}	1.74
CHF WP Transporter Load	> 5	COL + FHE	CHF_COLL_EQ + CHF_EQSUP_EQ	min{2.32, 1.74}	1.74
DTF Entrance Vestibule - SRTC	0.68	TOS	TRCSK_FIXT_EQ	1.45	1.45
DTF Entrance Vestibule - 200 ton Cask Handling Crane	> 5	COL + DSL + LOSP	DTF_COLL_EQ + DR_LOAD_DTC + (LOS_EQ + EQT_FS_DTC)	min{2.32, 1.45, max{0.1,1.45}}	1.45
DTF Turntable Preparation Rooms	> 5	COL + TOS	DTF_COLL_EQ + DTF_FIXT_EQ	min{2.32, 1.74}	1.74
DTF Cask and MSC Docking Room	> 5	COL + TOS	DTF_COLL_EQ + DTF_FIXT_EQ	min{2.32, 1.74 }	1.74

Table 16. Boolean Expression and HCLPF Capacity Evaluation for Event Sequences Involving DBGM-2 Structures, Systems, and Components (Continued)

Functional Area [a]	**Offsite Dose (rem)** [a]	**SET Model** [b]	**Boolean Expression for Event Sequence**	**HCLPF Capacity Calculation for Sequence Boolean (g)** [a,d]	**HCLPF Capacity for Sequence (g)** [c]
DTF NSNF Receipt - 200 ton Navy Cask Handling Crane	0.01 (Reassigned from DBGM1)	COL + DSL + LOSP	DTF_COLL_EQ + DR_LOAD_DTC + (EQT_FS_DTC + LOS_EQ)	min{2.32, 1.45, max{0.1,1.45}}	1.45
DTF NSNF Processing - 70 ton Navy Cask Handling Crane	0.01 (Reassigned from DBGM1)	COL + DSL + LOSP	DTF_COLL_EQ + DR_LOAD_DTC + (EQT_FS_DTC + LOD_EQ)	min{2.32, 1.45, max{0.1,1.45}}	1.45
DTF Waste Transfer - WP Docking	> 5	COL + FHE	DTF_COLL_EQ + DTF_EQSUP_EQ	min{2.32, 1.74}	1.74
DTF Waste Transfer - Cask and MSC Docking	> 5	COL + FHE	DTF_COLL_EQ + DTF_EQSUP_EQ	min{2.32, 1.74}	1.74
DTF Waste Transfer - Staging (Canisters)	> 5	COL	DTF_COLL_EQ	2.32	2.32
DTF WP Handling and Staging Cell - Staging [WP (Canister)]	> 5	COL + TOS	DTF_COLL_EQ + DTS_FIXT_EQ	min{2.32, 1.74 }	1.74
DTF WP Handling and Staging Cell - Bridge Crane [WP (Canister)]	> 5	DSL	DR_LOAD_DTC	1.45	1.45
DTF WP Handling and Staging Cell - WP Closure Cells [WP (Canister)]	> 5	COL + TOS	DTF_COLL_EQ + DTS_FIXT_EQ	min{2.32, 1.74}	1.74
DTF WP Loadout [WP (Canister)]	> 5	COL + FHE	DTF_COLL_EQ + DTF_EQSUP_EQ	min{2.32, 1.74}	1.74
DTF WP Remediation WP	> 5	COL	DTF_COLL_EQ	2.32	2.32

Table 16. Boolean Expression and HCLPF Capacity Evaluation for Event Sequences Involving DBGM-2 Structures, Systems, and Components (Continued)

Functional Area [a]	Offsite Dose (rem) [a]	SET Model [b]	Boolean Expression for Event Sequence	HCLPF Capacity Calculation for Sequence Boolean (g) [a,d]	HCLPF Capacity for Sequence (g) [c]
DTF Cask Restoration Room / Loaded MSC Removal	0.68	COL + TOS	DTF_COLL_EQ + DTN_FIXT_EQ	min{2.32, 1.74}	1.74
DTF Dry Remediation	> 5	COL	DTF_COLL_EQ	2.32	2.32
DTF Wet Remediation - Laydown Area, Cask Wet Remediation Entrance Vestibule	> 5	COL	DTF_COLL_EQ	2.32	2.32
DTF DPC Cutting	0.96	TOS + FHE	DPC_FIXT_EQ + DPCC_EQSUP_EQ	min{1.74, 1.74}	1.74
FHF Entrance Vestibule	> 5	COL + TOS	FHF_COLL_EQ + FHE_FIXT_EQ	min{2.32, 1.74}	1.74
FHF Preparation/Restoration Area	> 5	COL + TOS	FHF_COLL_EQ + FHE_FIXT_EQ	min{2.32, 1.74}	1.74
FHF Transfer Cell	> 5	DSL + TOS	DR_LOAD_FHF + TRCSK_FIXT_EQ	min{1.45, 1.74}	1.45
FHF Transfer Cell - Pits (MSC and WP)	> 5	FHE	FHF_EQSUP_EQ	1.74	1.74
FHF Loaded MSC Receipt	> 5	DSL + FHE	DR_LOAD_FHF + FHF_EQSUP_EQ	min{1.45, 1.74}	1.45
FHF WP Closure Cell	> 5	TOS + FHE	FHC_FIXT_EQ + FHF_EQSUP_EQ	min{1.74, 1.74}	1.74
FHF WP Loadout Area	> 5	COL + FHE	FHF_COLL_EQ + FHF_EQSUP_EQ	min{2.32, 1.74}	1.74
WP Subsurface Transport and Emplacement - WP Transporter	> 5	TOS	SSC_TRAN_EQ	1.45	1.45

Table 16. Boolean Expression and HCLPF Capacity Evaluation for Event Sequences Involving DBGM-2 Structures, Systems, and Components (Continued)

Functional Area [a]	Offsite Dose (rem) [a]	SET Model [b]	Boolean Expression for Event Sequence	HCLPF Capacity Calculation for Sequence Boolean (g) [a,d]	HCLPF Capacity for Sequence (g) [c]
SNF Aging Facility MSC Transport (Canister)	> 5	TOS	SMSC_TRAN_EQ	1.45	1.45
DTF Waste Transfer - Staging (CSNF)	2.26	COL + RC	DTF_COLL_EQ + DTF_RCK_EQ	min{2.32, 2.90}	2.32
Total Dose from the loss of Safety Function for DBGM-2 SSCs [c]	> 5				
		Net HCLPF for DBGM-2 event sequences: {min} [b] =			**{1.45}**

NOTES: [a] See Table 4 for source of dose values, and Table 14 for HCLPF capacities.

[b] Items without operation-specific SET Model are not shown; see Table 12.

[c] HCLPF capacity for all DBGM-2 is minimum HCLPF capacity of SSCs.

[d] Boolean expression for all DBGM-2 is UNION OR logic of the Boolean expressions of all the sequences.

CSNF = commercial spent nuclear fuel; DBGM = design basis ground motion; DPC = dual-purpose canister; DTF = Dry Transfer Facility; HCLPF = high confidence of low probability of failure; MSC = monitored geologic repository site-specific cask; RB = Remediation Building; SRTC = site rail transfer cart; SSCs = structures, systems, and components; WP = waste package.

Furthermore, Figure 11 applies OR logic to combine the Boolean expressions from Tables 12 and 13 to obtain the facility-wide HCLPF capacity for the top event, "Seismic Failures Result in Dose $\geq$ 5 rem (or unknown)". However, the seismic failures of the DBGM-1 SSCs do not contribute to the Boolean expression for exceeding 5 rem. Therefore, the HCLPF capacities derived in Table 16 result in 1.45 g for the repository-wide HCLPF capacity, based on the analysis presented. This HCLPF capacity is the ground acceleration at which there is a probability of 0.01 of exceeding the offsite dose limit of 5 rem TEDE.

Because the PGA for the BDBGM at the surface is estimated as 1.19 g (Table 1) and the repository-wide HCLPF capacity of 1.45 g exceeds this value, the preliminary repository design is demonstrated to be sufficient based on the analysis presented herein.

7. RESULTS AND CONCLUSIONS

This calculation provides a seismic preclosure safety analysis to support the DOE License Application design effort for a repository at Yucca Mountain and provides the assignment of DBGM-1 and DBGM-2 design bases to SSCs credited in the prevention of seismic event sequences.

To establish a basis for the classification of SSCs ITS, which are credited in the prevention or mitigation of a seismically-initiated event sequence, an identification of potential seismic event sequences was performed. The results of this evaluation are included in Attachment III. Using the defined probability-based levels of design basis ground motions (i.e., DBGM-1 and DBGM-2) in Table 1, each functional area and major system was assigned a DBGM level based on the potential offsite dose (Table 4). A limited number of DBGM-1 facilities were re-classified to DBGM-2 to comply with 10 CFR 63.111 such that the failure of all DBGM-1 facilities would not exceed 5 rem. Using this assessment, the classification of DBGM levels to identified SSCs ITS was performed and is presented in Tables IV-1 and IV-2.

Assigning DBGM-1 to SSCs prevents seismically initiated event sequences that could expose workers, onsite public, or offsite public to doses that exceed the performance objectives for Category 1 event sequences, as defined in 10 CFR 63.111(a) and (b)(1). Assigning DBGM-2 to SSCs prevents seismically initiated event sequences that could 1) expose the offsite public to doses that exceed the performance objectives for Category 2 event sequences, as defined in 10 CFR 63.111(b)(2), or 2) potentially lead to a criticality condition.

For preclosure seismic analyses to address 10 CFR 63 requirements, a method for computing seismic margins has been described in this calculation and the methodology has been demonstrated. The seismic margins analysis demonstrates that SSCs designed for DBGM-2 will ensure a high-confidence of low probability of failure that the Category 2 performance objectives will be achieved even for the accelerations associated with the BDBGM levels. Section 6.1 summarizes the methods for this calculation, Section 6.1.1 provides the stages and steps to be performed for the seismic calculation, Attachment II provides a description of methods, and Sections 6.3 and 6.4 provide the analysis of doses to the public and workers, respectively, together with an evaluation of interactions in Section 6.5.

To provide an estimate of facility-wide HCLPF capacity, a logic network was established (composed of fault and event trees) to describe the earthquake-initiated sequences and identify simplified trees to be used in the HCLPF calculation for offsite dose. The result of the analyses for facility-wide HCLPF capacity for preventing an offsite dose that exceeds 5 rem (represented by Figure 11) is 1.45 g, which compares favorably with 1.19 g (i.e., BDBGM in Table 1 for surface).

In addition, the minimum DBGM-2 HCLPF capacity (i.e. 1.45 g, from Table 16) exceeds the BDBGM margin value of 1.19 g for the surface facilities. Therefore, as all HCLPF capacities exceed margin values, sufficient margin has been demonstrated for the repository.

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ATTACHMENT I
SKETCH OF SURFACE LAYOUT

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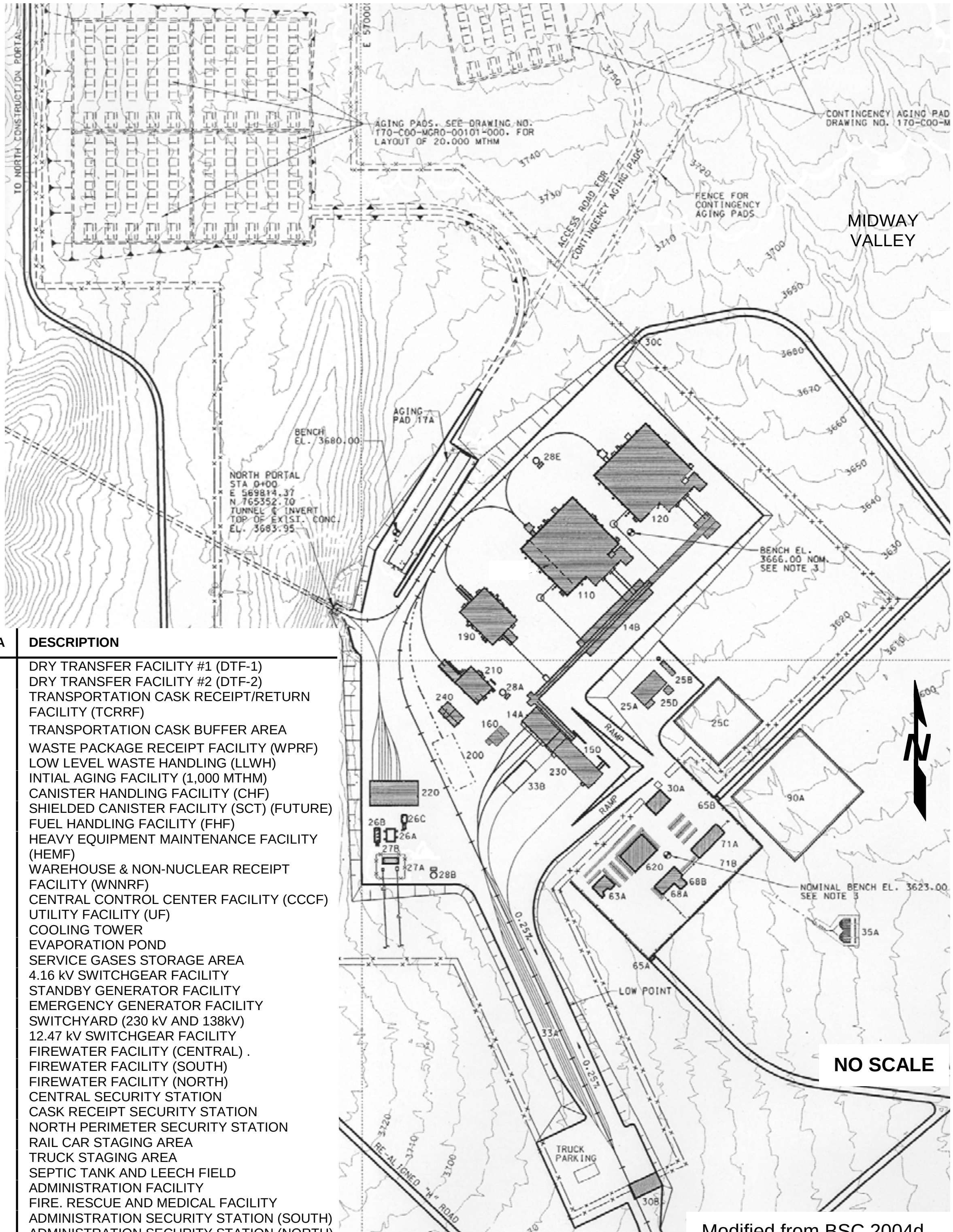
ATTACHMENT I

SKETCH OF SURFACE LAYOUT

Attached is a sketch of the repository facilities as presently understood (Figure I-1). It depicts the location of surface waste handling facilities such as the CHF, DTF, FHF, and additional SNF aging facilities. A list identifying structures in this figure that handle HLW (or directly support HLW-handling operations) is presented in Table I-1.



AREA	DESCRIPTION
110	DRY TRANSFER FACILITY #1 (DTF-1)
120	DRY TRANSFER FACILITY #2 (DTF-2)
14A	TRANSPORTATION CASK RECEIPT/RETURN FACILITY (TCRRF)
14B	TRANSPORTATION CASK BUFFER AREA
150	WASTE PACKAGE RECEIPT FACILITY (WPRF)
160	LOW LEVEL WASTE HANDLING (LLWH)
17A	INTIAL AGING FACILITY (1,000 MTHM)
190	CANISTER HANDLING FACILITY (CHF)
200	SHIELDED CANISTER FACILITY (SCT) (FUTURE)
210	FUEL HANDLING FACILITY (FHF)
220	HEAVY EQUIPMENT MAINTENANCE FACILITY (HEMF)
230	WAREHOUSE & NON-NUCLEAR RECEIPT FACILITY (WNNRF)
240	CENTRAL CONTROL CENTER FACILITY (CCCF)
25A	UTILITY FACILITY (UF)
25B	COOLING TOWER
25C	EVAPORATION POND
25D	SERVICE GASES STORAGE AREA
26A	4.16 kV SWITCHGEAR FACILITY
26B	STANDBY GENERATOR FACILITY
26C	EMERGENCY GENERATOR FACILITY
27A	SWITCHYARD (230 kV AND 138kV)
27B	12.47 kV SWITCHGEAR FACILITY
28A	FIREWATER FACILITY (CENTRAL) .
28B	FIREWATER FACILITY (SOUTH)
28E	FIREWATER FACILITY (NORTH)
30A	CENTRAL SECURITY STATION
30B	CASK RECEIPT SECURITY STATION
30C	NORTH PERIMETER SECURITY STATION
33A	RAIL CAR STAGING AREA
33B	TRUCK STAGING AREA
35A	SEPTIC TANK AND LEECH FIELD
620	ADMINISTRATION FACILITY
63A	FIRE. RESCUE AND MEDICAL FACILITY
65A	ADMINISTRATION SECURITY STATION (SOUTH)
65B	ADMINISTRATION SECURITY STATION (NORTH)
68A	WAREHOUSE/CENTRAL RECEIVING
71A	CRAFT SHOPS
71B	EQUIPMENT/YARD STORAGE
90A	STORM WATER RETENTION POND

Modified from BSC 2004d

Figure I-1. Sketch of Surface Facilities Layout

Table I-1. Identification of High-Level Waste Handling Related Structures at Surface

Facility Description	HLW Handling Related System / Facility
Dry Transfer Facility #1 (DTF-1)	√
Dry Transfer Facility #2 (DTF-2)	√
Transportation Cask Receipt/Return Facility (TCRRF) - Cask Receipt and Return Area [a,b]	√
Transportation Cask Receipt/Return Facility (TCRRF) - Transportation Cask Buffer Area [b]	√
Waste Package Receipt Facility (WPRF) [a]	—
Low-Level Waste Handling (LLWH)	—
Aging Facility - Initial (1,000 MTHM)	√
Aging Facility - #1 (5,000 MTHM)	√
Aging Facility - #2 (5,000 MTHM)	√
Aging Facility - #3 (5,000 MTHM)	√
Aging Facility - #4 (5,000 MTHM)	√
Canister Handling Facility (CHF)	√
Fuel Handling Facility (FHF)	√
Heavy Equipment Maintenance Facility (HEMF)	—
Warehouse & Non-Nuclear Receipt Facility (WNNRF) [a,b]	—
Central Control Center / Primary Alarm System	—
Utility Facility (UF)	—
Cooling Tower	—
Evaporation Pond	—
Switchgear Facility	—
Standby Generator Facility	—
Emergency Generator Facility	—
Switchyard (230 kV AND 138 kV)	—
Switchgear Facility (12.1 kV)	—
Firewater Facility (Central)	—

Table I-1. Identification of High-Level Waste Handling Related Structures at Surface (Continued)

Facility Description	Waste Handling Related System / Facility
Firewater Facility (North)	—
Firewater Facility (South)	—
Central Security Station	—
Cask Receipt Security Station	—
North Perimeter Security Station	—
Railcar Staging Area [c]	√
Truck Staging Area [c]	√
Septic Tank and Leach Field	—
Administration Facility	—
Fire, Rescue and Medical Facility	—
Administration Security Station	—
Warehouse/Central Receiving	—
Craft Shops	—
Equipment/Yard Storage	—
Storm Water Retention Pond	—

NOTES: [a.] The WNNRF contains the WPRF. The structure housing the WNNRF and Cask Receipt and Return Area of the TCRRF is termed the Cask and Waste Package Receipt Building (CWPRB).

[b.] Grouped as *Receipt Systems* for present analysis.

[c.] Grouped as *Transportation Facility* for present analysis

HLW = high-level radioactive waste; MTHM = metric tons of heavy metal; kV = kilovolts.

ATTACHMENT II
DESCRIPTION OF ANALYSIS METHODS

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ATTACHMENT II

DESCRIPTION OF ANALYSIS METHODS

II.1 Background

This attachment provides an overview of the methods that will be used in this calculation. The analysis is based on the preclosure design methodology developed for Yucca Mountain (BSC 2004u). The methodology stipulates that an SSC ITS that is credited in the prevention or mitigation of a seismically-initiated event sequence be designed to withstand seismic design levels DBGM-1 or DBGM-2, depending on the resulting dose to repository workers or the public should the SSC lose its safety function due to an earthquake. The methodology defines the seismic hazard level associated with a respective DBGM and adopts a seismic margins methodology to address the requirements of 10 CFR Part 63. It should be noted that the methodology in BSC (2004u) supersedes earlier descriptions as in YMP (1997a), which was based on 10 CFR Part 60.

Seismic design input parameters include PGA, the spectral accelerations at different frequencies and peak ground velocity that are predicted to occur for various MAPE levels for the Yucca Mountain site in accordance with a probabilistic seismic hazards analysis (YMP 1997b). The reference earthquakes (BSC 2004u, Section 3.1.1) to be used as the design bases for SSCs ITS are defined as follows:

- DBGM-1 is the ground motion having a MAPE of 1.0×10^{-3} (i.e., a return period of 1,000 years).
- DBGM-2 is the ground motion having a MAPE of 5.0×10^{-4} (i.e., a return period of 2,000 years).

The two DBGM ground motion levels represent reasonable annual probability of exceedance levels relative to precedents adopted for nuclear facilities (e.g., BSC 2004u, Sections 3 and 3.4) in accordance with the discussion in 10 CFR 63.102(f), which states:

> *Preclosure safety analysis.* Section 63.111 includes performance objectives for the geologic repository operations area for the period before permanent closure and decontamination or permanent closure, decontamination, and dismantlement of surface facilities. The preclosure safety analysis is a systematic examination of the site; the design; and the potential hazards, initiating events and their resulting event sequences and potential radiological exposures to workers and the public. Initiating events are to be considered for inclusion in the preclosure safety analysis for determining event sequences only if they are *reasonable (i.e., based on the characteristics of the geologic setting and the human environment, and consistent with precedents adopted for nuclear facilities with comparable or higher risks to workers and the public).* The analysis identifies structures, systems, and components important to safety. [Italics added for emphasis]

In addressing the requirements of 10 CFR Part 63, the analysis will invoke a more limiting, reference level earthquake for each SSC ITS assigned to DBGM-2, termed as the beyond-design basis ground motion" event or BDBGM (BSC 2004u, Section 3.3.1). This level is also in accordance with precedent (BSC 2004u, Section 3). Structural analyses will be conducted for SSCs ITS at these BDBGM levels to demonstrate the capacity of the SSCs to perform their intended safety functions at ground motion levels that are greater than the design basis ground motions.

II.2 Assignment of Design Basis Ground Motions to SSCs

The assignment of the respective DBGM levels to SSCs ITS (that are credited in the prevention or mitigation of a seismically-initiated event sequence) is tied to the dose limits established in the performance requirements of 10 CFR 63.111 (with reference to 10 CFR 63.204 and 10 CFR 20.1201) for Category 1 and Category 2 event sequences. Table 2 summarizes the bases for DBGM assignments to SSCs ITS for the present analyses.

As a minimum, DBGM-1 is assigned to an SSC if the seismic failure of the SSC (i.e., loss of the SSC safety function) could result in a dose equal to or greater than 5 rem TEDE to a radiation worker, greater than 2 mrem to an on site public or non-radiation worker or 15 mrem TEDE to the public at the site in the General Environment (Table 2, Section 4.1.11). Similarly, DBGM-2 is assigned to an SSC if the seismic failure of the SSC could result in a dose equal to or greater than 5 rem to the public at the boundary of the site or beyond. Should it be shown that concurrent seismic failures of multiple SSCs initially assigned to DBGM-1 could result in a public dose of 5 rem TEDE or more, one or more of those SSCs must be re-assigned to the DBGM-2 category.

Some special conditions are noted in this approach. Whenever the potential consequences of a seismic sequence could result in the breach of a DSNF canister, no dose calculations are performed, and such SSCs are assigned to the DBGM-2 category (Assumption 5.13). In addition, whenever the potential consequences of a seismic sequence could result in a criticality condition, no dose calculations are performed, and such SSCs are assigned to the DBGM-2 category.

There are two pathways for identifying SSCs ITS credited in the prevention or mitigation of a seismically-initiated event sequence. The first pathway is the analysis of event sequences for internal hazards and identification of SSCs credited in the prevention or mitigation of internal event sequences (BSC 2004p; BSC 2004s). The initiating events and loss of safety functions of the credited SSCs are postulated to be vulnerable to seismic failures, and DBGMs are assigned in accordance with the dose or criticality that could result. Such seismic event sequences are postulated to cause initiating events that could otherwise occur from random failures (i.e., independent of an earthquake), such as drop of waste forms by handling equipment, LOSP, and fires.

Depending on the design bases of various SSCs and intensity of the ground motion associated with a given earthquake, it is possible, although unlikely, for many or all of the internal event sequences to be triggered concurrently by the seismically-induced loss of safety function.

The second pathway for identifying SSCs ITS is the analysis of seismically-initiated event sequences that were not identified in the internal event analysis. Such event sequences include seismic failures of passive SSCs, such as transfer cell walls and ceiling, support structures of cranes and handling equipment, or disassembly of spent fuel assembly staging racks. The seismic failure (loss of safety function) of each SSC is postulated, and the potential doses are assessed (except in the case of potential DSNF canister breach). DBGMs are assigned in accordance with the stated dose guidelines (Table 2). Again, depending on the design bases of various SSCs and the intensity of the ground motion associated with a given earthquake, it is possible, although unlikely, for the failure of passive components and the internal event sequences to be triggered concurrently.

At the completion of the seismic PCSA, the SSCs that must be credited to prevent or mitigate seismic event sequences are assigned a DBGM category that will be reflected in the 10 CFR 63.2 design bases and are input to the safety classification analysis.

II.3 Regulatory Approach

II.3.1 General

There are two requirements that must be met to address the intent of 10 CFR Part 63, as described in the following:

1. The first requirement stems from the principles cited in *Preclosure Seismic Design Methodology for a Geological Repository at Yucca Mountain* (BSC 2004u, Section 3.1.1):

    - The repository design must meet the dose limits for Category 1 event sequences specified in 10 CFR 63.111(b)(1) when subjected to ground motions associated with DBGM-1.

    - The repository design must meet the dose limits for Category 2 event sequences specified in 10 CFR 63.111(b)(2) when subjected to ground motions associated with DBGM-2.

    These compliance requirements will be satisfied by assigning the respective DBGMs to SSCs ITS to prevent or mitigate doses that could exceed the respective limits for Category 1 and Category 2 event sequences. An examination of event sequences initiated by the seismic failure of an SSC non-ITS that might cause an SSC ITS to lose its safety function, needs to be performed.

2. The second requirement is to demonstrate that any seismic event sequence whose consequences could exceed the dose limits specified in 10 CFR 63.111(b)(2) for Category 2 event sequences is less likely than the Category 2 probability threshold. This requirement stems from the 10 CFR 63.2 definition of a Category 2 event sequence, as follows:

> *Event sequence* means a series of actions and/or occurrences within the natural and engineered components of a geologic repository operations area that could potentially lead to the exposure of individuals to radiation. An event sequence includes one or more initiating events and associated combinations of repository system component failures, including those produced by the action or inaction of operating personnel. Event sequences that are expected to occur one or more times before permanent closure of the geologic repository operations area are referred to as Category 1 event sequences. Other event sequences that have at least one chance in 10,000 of occurring before permanent closure are referred to as Category 2 event sequences.

Since the preclosure operational period is nominally 100 years (Assumption 5.12), the above definition is equivalent to saying that a Category 2 event sequence has an annual probability of occurrence, often termed frequency, of at least 1×10^{-6}. The basis for demonstrating compliance with 10 CFR Part 63 for seismic event sequences is the requirement that the dose from no seismically-induced Category 2 event sequence exceed the dose limit specified in 10 CFR 63.111(b)(2).

Thus, to demonstrate compliance with 10 CFR Part 63 for seismic sequences, it must be shown that the annual probability of exceeding 5 rem TEDE to the public is sufficiently small. In this analysis, the method of seismic margins analysis is used to demonstrate that the repository systems are designed to exhibit a high confidence of a low probability of failure where failure (i.e., the loss of the credited safety function) results in a dose in excess of 5 rem TEDE.

Although dose limits for specific organs are given in 10 CFR 63.111 and are considered in PCSA evaluations of compliance, the current analysis is based on compliance with the offsite dose limit of 5 rem TEDE. Should special circumstances in a seismically-initiated sequence result in an organ dose being more limiting in assigning DBGM levels, SSCs involved in the sequence will be assigned to the more limiting DBGM.

II.3.2 Design Considerations

The assignment of the DBGM-1 to various SSCs ITS stipulates that there are no seismically-initiated event sequences for ground motions corresponding to a MAPE of 1×10^{-3} or higher. The margins in the design ensure that the conditional probability of failure is essentially zero when subjected to design bases ground motion (or less severe vibratory ground motions). Consequently, there are no seismically-initiated Category 1 event sequences that result in doses to workers or the public.

However, seismically-initiated event sequences can occur for ground motions greater than DBGM-1. As the MAPE of such ground motions decreases from 1×10^{-3} to say 5×10^{-4}, the accelerations increase and the margin to failure decreases of DBGM-1 SSCs. Depending on the seismic design margins for various SSCs designed to DBGM-1, one or more SSCs could lose their safety functions following an earthquake that is more intense than the DBGM-1 ground motions and, thereby, result in one or more seismically-initiated event sequences. The total dose from such event sequences could exceed the 10 CFR 63.111(b)(1) limits for Category 1 event sequences. However, such event sequences would be considered Category 2 event sequences and unless the total dose exceeds 5 rem total effective dose equivalent to the public, the resulting doses are in compliance with 10 CFR 63.111(b)(2) limits for Category 2 event sequences.

In the event that the analysis indicates that the total dose exceeds 5 rem to the public at the boundary of the site or beyond, were all of the SSCs assigned to DBGM-1 to fail, then one or more of the affected SSCs is reassigned to the DBGM-2 category and designed accordingly. The reassignment of SSCs to DBGM-2 continues until the total dose from postulated failure of the remaining DBGM-1 SSCs is less than 5 rem. This process is not performed for worker dose, as there is no worker dose limit associated with Category 2 event sequences. Therefore, it is not necessary for compliance evaluations to consider the total worker dose that might result if multiple DBGM-1 SSCs were to fail in an earthquake that is more intense than a level DBGM-1 event.

The assignment of the DBGM-2 to various SSCs ITS means that there are no event sequences initiated by the seismically-induced failures of SSCs assigned to DBGM-2 for ground motions corresponding to a MAPE of 5×10^{-4} or higher. Note that in the DBGM-2 assignment, the margin in the design ensures that the conditional probability of failure is negligible when subjected to design bases ground motions. For SSCs assigned to a DBGM-2 level, margin is also demonstrated to a BDBGM level or a MAPE of 1×10^{-4}. This limiting probability level is considered to be reasonable, based on the characteristics of the geologic setting and the human environment, and consistent with precedents adopted for nuclear facilities with comparable or higher risks to workers and the public, in accordance with the provisions of 10 CFR 63.102(f), and, therefore, compliant with the total framework of the regulation.

II.3.3 Seismic Margins Analysis

As noted earlier, the SMA method is employed for this analysis. SMA is one of the methods accepted by the NRC for NPPs to demonstrate compliance with the purpose of an individual plant examination of external events, as stated in *Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities* (Chen et al. 1991, Section 3.2.1). A seismic probabilistic risk assessment is the other acceptable method and several guidance documents are available (e.g., NRC 2002, ASME RA-S-2002, *Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications*).

The objective of a SMA is to demonstrate that there is high confidence of low probability of failure to comply with a stated safety criterion (i.e., that the safety criterion is not exceeded). For NPPs, the safety criterion is preventing core damage (Prassinos et al. 1986, p. 3). The risk associated with NPPs is expressed in terms of achieving an acceptable core damage frequency or large early release [of radioactivity] frequency (LERF) that meets NRC guidelines (e.g. NRC 2002, Section 19.II, p. SRP 19-6).

10 CFR Part 63 does not define an overall, or integral, risk goal for the repository. However, the risk goal adopted for this analysis is to demonstrate that the annual probability of exceeding a

public dose of 5 rem TEDE is less than the MAPE of the BDBGM, in accordance with the provisions of 10 CFR 63.102(f).

The term, *seismic margin*, was introduced in the nuclear power plant industry where studies by industry and the NRC have shown that NPPs are capable of withstanding earthquake motion substantially greater than the safe shutdown earthquake (SSE) acceleration (Prassinos et al. 1986, p. 1). *Preclosure Seismic Design Methodology for a Geological Repository at Yucca Mountain* (BSC 2004u, Section 3.2, p. 19) states that, with exceptions as noted, the DOE considers that the approach to seismic design for the SSE given in applicable subsections of the Standard Review Plan for NPPs (i.e., Section 3.7.1 [NRC 1989a], Section 3.7.2 [NRC 1989b], Section 3.7.3 [NRC 1989c], and Section 3.10 [NRC 1981]), provides appropriate acceptance criteria for the seismic design of repository surface facilities that are important to safety. Application of Standard Review Plan design procedures and acceptance criteria, in large measure, means replacing the term SSE with the terms DBGM-1 or DBGM-2. Therefore, the repository SSCs ITS have margin to loss of safety function that is substantially greater than the ground motion to which the SSCs are designed.

For NPPs, the design basis earthquake is specified as the SSE. Typically, the SSE has a PGA on the order of 0.22 g (where g is the acceleration of gravity) for NPPs in the eastern U.S. (Kennedy et al. 1980, p. 320) and as high as 0.75 g for NPPs on the west coast (YMP 1997a, p. C-1). Through structural analysis of SSCs to quantify their strength margins to withstand forces imposed by earthquakes, it is determined at what PGA the conditional probability of failure (loss of safety function) is 0.01 or less. The ground motion associated with the 0.01 probability of loss of safety function is termed the *HCLPF capacity* of the SSC.

The PGA of the HCLPF capacity is significantly greater than the PGA associated with the SSE. In NPP SMAs, it is customary to define a review level earthquake or BDBGM that has twice the intensity of the SSE. The NRC has binned NPPs into 0.3 g and 0.5 g for SMA considerations (Chen et al. 1991, Section 3.2.2). Compliance with the individual plant examination of external events' guidance for NPP is demonstrated when the plant level HCLPF capacity equals or exceeds the ground motion of the BDBGM that has a PGA of about twice that of the review level earthquake (i.e., either 0.3 g or 0.5 g). Section 4.2 of Prassinos et al. (1986) notes that selecting a review earthquake greater than 0.5 g will preclude the screening out of components based on generic capacities.

In SMA for NPPs, a HCLPF capacity is determined for each SSC that appears in safe-shutdown event sequences, and a plant-level HCLPF capacity is determined from systems analysis as that minimum PGA for which no safe-shutdown path exists, thereby, leading to core damage.

For the repository, the DBGM-1 and DBGM-2 ground motions are adopted as the design basis earthquakes (counterparts of the SSE for NPPs) and considered "reasonable" with respect to nuclear precedent per 10 CFR 63.102(f) (BSC 2004u, Section 3.3.2). A systems analysis is performed to model seismic event sequences and identify the SSCs that contribute to credible seismically-initiated event sequences (e.g., those resulting in a dose greater than 5 rem TEDE). HCLPF capacities are determined for the SSCs and used in the systems model to determine the plant-level HCLPF capacity for the repository.

For margin computations, the BDBGM level selected for the repository is the ground motion associated with a MAPE of 1×10^{-4} for BDBGM. For the present approach, the minimum HCLPF capacities for the surface functional areas designated as DBGM-2 equal or exceed the BDBGM level.

SMA incorporates three distinct analyses:

- Systems analysis to define the event sequences that could result from a seismic-initiating event and identify the SSCs ITS that are credited in preventing or mitigating seismically-initiated event sequences

- Seismic capacity analysis of those SSCs ITS to determine the HCLPF capacity of each SSC ITS

- Combination of the system model and HCLPF capacities to determine the repository-wide level HCLPF capacity (e.g., Kennedy 2001).

When design detail permits, the analysis of HCLPF capacities is performed by design engineers and provides input to the seismic safety analysis. For the present analysis, HCLPF capacities are based on generic factors (Assumption 5.10).

The development of the system model and determination of the repository-wide level HCLPF capacity is the primary activity reported in this analysis.

II.4 Seismic Systems Analysis

II.4.1 Rationale

The intent of the seismic systems analysis is to conduct a systematic identification of potential seismically-initiated event sequences and their preclosure safety consequences. The seismic systems analysis provides the bases for assigning DBGMs to SSCs ITS and a framework for addressing the requirements of 10 CFR Part 63.

To the extent appropriate to the complexity of the analysis, the seismic systems analysis employs event tree and fault tree analysis methods. The event tree and fault tree analyses are used to develop logic models for individual SSCs and the overall repository that define the various ways that an undesired consequence could result from seismically-initiated event sequences. As appropriate to the amount of design detail available, the analysis includes the effects of random failures (independent of the seismic ground motions) and human failure events (HFEs) that may be exacerbated in the aftermath of an earthquake. The results of event tree and fault tree analyses identify how seismically-induced failures of an individual SSC, combinations of seismically-induced failures of multiple SSCs, or combinations of seismically-induced and random failures of multiple SSCs or HFEs, or both, lead to undesired consequences.

The following sections describe the applications of event and fault tree methods to the seismic systems analysis.

II.4.2 Master Logic Diagram

A master logic diagram (MLD) is an application of fault tree logic that aids in performing a thorough, structured identification of potential seismic concerns in the repository. A MLD is not necessary, but its graphic display has the advantages over a tabular listing of ensuring completeness and identifying potential correlation between seismic event sequences.

Figure II-1 shows a MLD for the seismic analysis of the repository in a fault tree format. The top event in Figure II-1, “Release of Radioactivity Due to Earthquake,” is developed as an OR-gate that includes each of the facilities or operations that contain radioactive material.

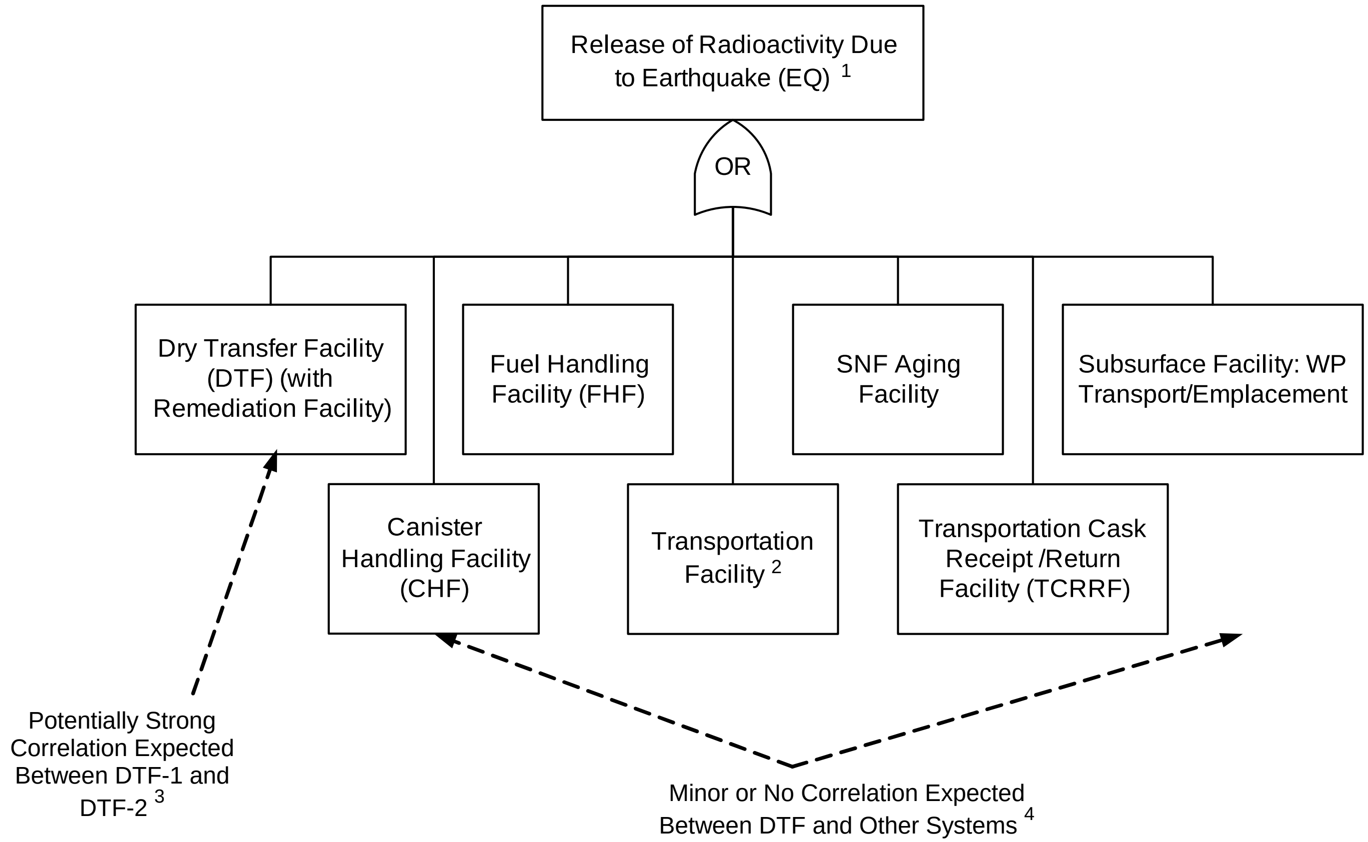
A MLD identifies that releases could occur simultaneously from surface and subsurface handling and processing operations as well as from transport operations and an aging facility. A MLD must be based on a specific repository design. For example, Figure II-1 is based on the latest design information (Section 4.1.2).

The structure of the MLD guides the development to lower levels of assembly to identify specific buildings, functional areas, or operations where radioactive waste is being processed or stored and, thereby, potentially vulnerable to a seismically-induced release of, or exposure to, radiation. Such detailed development may employ event tree and/or fault tree analysis.

The annotations in Figure II-1 identify locations where an earthquake could potentially initiate releases and exposures at the same time, given an earthquake of sufficient intensity. Each of the events under the OR-gate in Figure II-1 could be described more completely as “Release of Radioactivity from DTF-1 Due to Earthquake,” as illustrated in Figure II-2.

Figure II-2 illustrates how the MLD logic can be continued to lower levels of assembly to identify potential release scenarios. This figure addresses either of the two DTFs. The OR-gate logic emphasizes the fact that any one of the scenarios listed could result in the undesired top event “Release of Radioactivity from DTF Due to Earthquake.” However, it is more convenient to list potential initiating events for each functional area in a table. The detailed development of seismic event sequences uses tables, event trees, and fault trees, as appropriate, to systematically identify the potential event sequences and failure modes that come into play.

In general, seismic failures in diverse facilities and operations are uncorrelated with respect to their conditional probability of failure in the presence of an earthquake of given intensity. However, duplicate structures may be correlated such that given a seismic failure in one DTF (with a specific seismic capacity of the structure and earthquake intensity) is assumed to occur with conditional probability of 1.0 in the other DTF. The MLD in Figure II-1 is annotated to indicate where DTFs of the same design may be highly correlated. The figure also indicates that minor or no correlation is expected among the other facilities and operations with DTF.



NOTES:

1. System and building names are modified from BSC (2004d).
2. Transportation Facility includes the Railcar Staging Area and Truck Staging Area.
3. For this analysis, complete correlation is assumed (Assumption 5.8).
4. For this analysis, no correlation is assumed (Assumption 5.9).

Figure II-1. Master Logic Diagram for Seismic Preclosure Safety Analysis for Dose to the Public or Workers

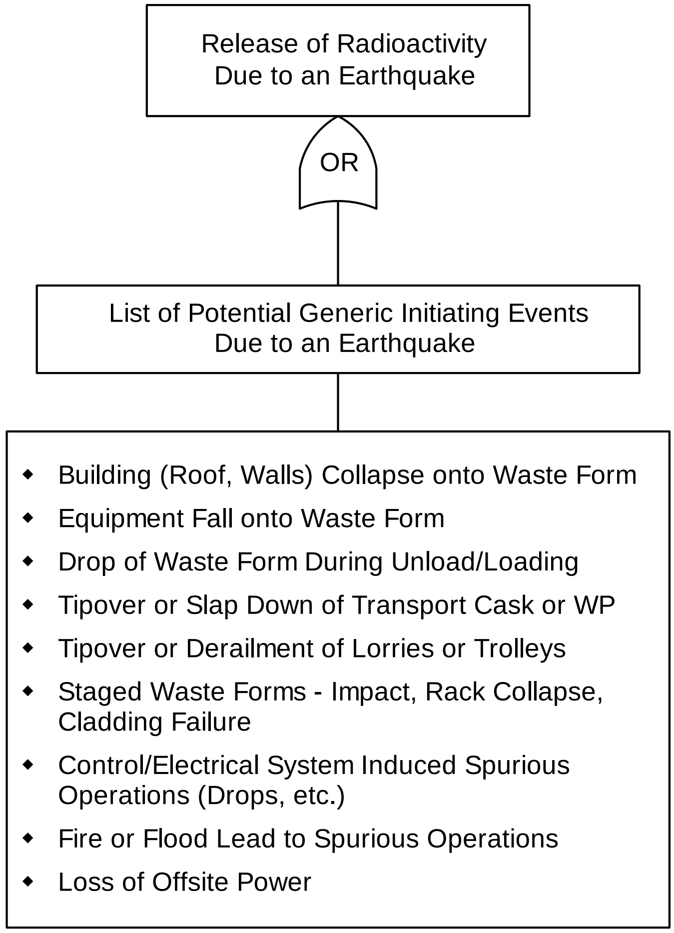


Figure II-2. Master Logic Diagram for Seismic Preclosure Safety Analysis for Dry Transfer Facility

II.4.3 Seismic Event Trees

Seismic event trees (SETs) are developed to display the various seismic event sequences that could be initiated in a particular operation or facility. A SET for a given facility or operation is created for each initiating event that is identified as being a potential start of an undesired event sequence. One basis for SET creation considers event sequences and consequence analyses that have been developed for independent (random) initiating events. Such initiating events include drops of waste forms, LOSP, and fires inside the waste handling facility. Each initiating event that could be initiated by an earthquake is incorporated into a SET.

Another basis for SET creation is identification of initiating events and event sequences that are unique to seismic scenarios. Such initiating events include failure of staging racks full of spent-fuel assemblies, collapses of roofs or walls of surface structures onto fuel assemblies or canisters, fall of heavy cranes or equipment onto fuel assemblies or canisters, or loosening and fall of large rock blocks onto WPs in emplacement drifts.

Attachment V describes several generalized SETs for seismically-induced initiating events. These SETs are termed generalized because they include one or more event headings that may be screened out or deleted as a result of assumptions used and the amount of detail available for modeling in the SET. The trees that result from this screening are termed, simplified SETs.

Figure II-3 illustrates a generalized SET for a drop of a waste form. In this example, the initiating event is the earthquake. Two heading events are noted whose failures could result in the drop of a suspended waste form. One heading, event "Crane or Fuel Handling Machine Structure Intact" (labeled "EQPT_SUP), would result from a passive failure in a non-seismic analysis (and, thereby, would be screened-out as a low-probability event). However, a failure of a passive SSC can be a seismically-initiated.

The second heading event is "Crane or Fuel Handling Machine Maintains Load" (labeled "DR_LOAD"), whose failure could be caused by either seismic effects or random failures in the mechanisms or control system. The frequency of the event DR_LOAD (random event) would be used in a SET for an internal event analysis. In this SET, however, the event DR_LOAD represents the conditional probability of dropping the waste form or failure of the support structure, conditioned on the intensity of the earthquake.

The event heading "Waste Form Present in Operation (Occupancy Factor)" (labeled "OF_TRAN") is included in the SET to emphasize the fact that potential seismic event sequences cannot occur if no waste form is present in a particular operation. The value of the "yes" fraction representing OF_TRAN is estimated from the number of operations per year and the time per operation when the waste form is at risk. For dry transfer operations of commercial SNF, the "yes" fraction of OF_TRAN may be expected to be close to 1.0. However, the "yes" fraction representing OF_TRAN for dry transfer of DSNF canisters is expected to be less than 1.0.

The SETs in Attachment V include similar events labeled OTF_CELL, OTF_STAG, and OTF_TROL. The events represent both occupancy factors and target factors. A target factor considers the fraction of time that a machine subject to seismic failure is above a vulnerable waste form, or the probability that a portion of collapsing structure strikes a vulnerable waste form. There must be sufficient design and operational information to quantify the "yes" fractions for OF_TRAN, OTF_CELL, OTF_STAG, and OTF_TROL; otherwise, the value should be set equal to 1.0 and the event heading is eliminated from the SETs to simplify the analysis. Nevertheless, where appropriate, qualitative arguments can be used regarding occupancy or target factors in screening out some seismic event sequences.

The three right hand columns of Figure II-3 and other SETs display, respectively, the Sequence Number (used for identification), the Damage State that results from the sequence of events (e.g., "OK" means no radiological consequences and "Release" means a source term is generated), and the Offsite Dose Type (i.e., "Mitigated," or "Unmitigated").

EARTHQUAKE OCCURS	CRANE OR FUEL HANDLING MACHINE STRUCTURE INTACT	CRANE OR FUEL HANDLING MACHINE MAINTAINS LOAD	WASTE FORM PRESENT IN OPERATION (OCCUPANCY FACTOR)	WASTE FORM DOES NOT BREACH	CONFINEMENT STRUCTURE REMAINS FUNCTIONAL	HVAC/HEPA FILTRATION REMAINS FUNCTIONAL	Sequence Number	Damage State	Offsite Dose Type
EQ	EQPT_SUP [1]	DR_LOAD	OF_TRAN	BR_DROP	CONF_CELL	HEPA_CELL			
Initiating EQ	Success	Success	N/A	N/A	N/A	N/A	1	OK	None
		Failure	No	N/A	N/A	N/A	2	OK	None
			Yes	Success	N/A	N/A	3	OK	None
				Failure	Success	Success	4	OK	None
						Guaranteed Failure	5	Release	Mitigated
					Failure	Guaranteed Failure	6	Release	Unmitigated
	Failure	Guaranteed Failure	No	N/A	N/A	N/A	7	OK	None
			Yes	Success	N/A	N/A	8	OK	None
				Failure	Success	Success	9	Release	Mitigated
						Guaranteed Failure	10	Release	Unmitigated
					Failure	Guaranteed Failure	11	Release	Unmitigated

NOTES

Event names (under event headings) refer to failure, not success.

BR_DROP = Waste form breaches; CONF_CELL = Confinement structure fails; DR_LOAD = Crane or fuel handling machine drops load; EQ = earthquake; EQPT_SUP = Crane or fuel handling machine structure fails; HEPA_CELL = HVAC/HEPA filtration fails; OF_TRAN = Waste form present when earthquake occurs.

Figure II-3. Seismic Event Tree: Drop of Suspended Waste Form

A SET provides the framework for quantifying the conditional probability of occurrence of undesired event sequences. The conditional probability of an event sequence that releases radioactivity following an earthquake will account for dependent and independent failures of SSCs and any human actions that come into play. This may require development of a fault tree model to support the SET event heading, as described in Section II.4.4. However, low-probability, independent and dependent failure events that do not contribute significantly to the seismic event sequences are screened out of event tree and fault tree models to simplify analysis.

In describing these models and results, the term *cutset* is used. A cutset is composed of one or more basic failure events, combined in AND logic that results in the top event of a fault tree model or the occurrence of a given event sequence. The term "single" is used to describe a cutset composed of one basic event. The occurrence of that single basic event results in the top event. The term "double" is used to describe a cutset composed of two basic events. Both of the basic events must occur to result in the top event. The term, "triple," and so on are used to describe higher order cutsets.

A cutset may include one or more independent failures, a seismic failure event and one or more independent events, or multiple seismic failure events. The SET logic models (linked to system fault tree models, as appropriate) are solved to determine the minimal cutsets that result in a given event sequence. Minimal cutsets define the individual failure events or combinations of failure events that could each result in the occurrence of the event sequence. Through the rules of Boolean algebra, the least number of unique cutsets that result in the event sequence is determined, and these are termed the minimal cutsets.

The probability that a fault tree top event or a given event sequence will occur is the union (i.e., OR logic, or arithmetic sum) of the probabilities of the minimal cutsets. The minimal cutsets are applied in developing the Boolean expression in the SMA analysis, as described in Section II.5.

A SET logic diagram may be constructed with any convenient graphics software. The SETs used in this analysis, for example, were drawn in Microsoft Visio. However, for more complex SET development and solution, a specialized program like SAPHIRE (Smith et al. 2000) could be used.

II.4.4 System Fault Trees

The fault tree logic models for active systems that appear in SET headings are modified to include potential seismically-induced failures. The top event in a system fault tree represents the conditional probability of the loss of a given safety function, conditioned on the occurrence of an earthquake. The top event probability has to be multiplied by the annual probability of exceedance of an earthquake to quantify the annual probability of a seismic event sequence. The basic events in the fault tree include potential independent failures, dependencies on electric power or cooling water, common-cause failures among like components/subsystems, and human-induced failures in addition to seismic failure events. All basic events in the fault tree represent probabilities of failure events that occur either as a result of ground motions associated with an earthquake, or failure events that occur concurrently with the earthquake but are independent of the ground motions.

Figure II-4 illustrates a fault tree for an active system that illustrates how seismically-induced faults, random failures, and human failure events could result in one of the event headings in a SET. The top event of the fault tree, "Crane or Fuel Handling Machine Fails to Maintain Suspended Load," is the failure event for an event heading in Figure II-3. The top event is developed as an OR-gate having two events: (1) a fault due to mechanical failures of the holding or lifting mechanism, and (2) a fault due to failures or spurious signals in the control system.

These two faults are each developed to a third level as OR-gates. The inputs to these two OR-gates are modeled as undeveloped events (indicated by the diamond symbols under each input event box).

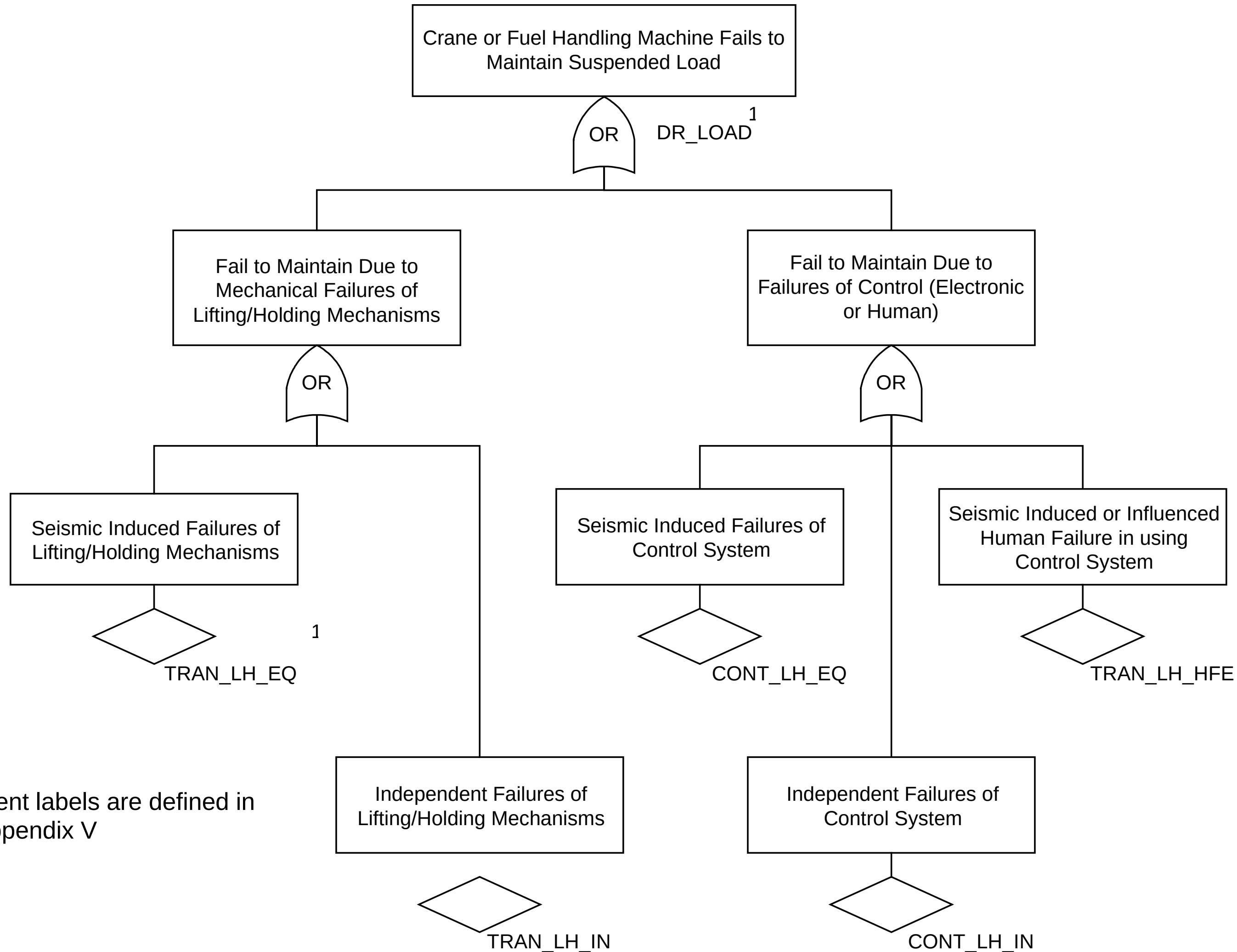
Each input event is named and identified by type of fault, e.g., TRAN_LH_EQ to represent seismically-induced failures of the mechanisms, TRAN_LH_IN to represent independent (or random) failures, and TRAN_LH_HFE to represent a human influenced or induced failure event. Event TRAN_LH_HFE is treated as a random failure that could occur independently of the ground motions but whose probability may be higher in the aftermath of an earthquake than under normal operating conditions. The input events in Figure II-4 are generic. Whether or not all of the inputs apply to a particular waste handling system depends on the design. Thus, the fault trees used in this analysis will be limited in detail but complete in identification of potential failure modes.

For seismic system analysis, it is efficient to screen out low-probability, independent failure events from the fault tree. For example, knowing that the DBGM-1 and DBGM-2 earthquakes have a MAPE of 1×10^{-3} and 5×10^{-4}, respectively, the occurrence of any random event having a probability of less than approximately 1×10^{-3} concurrent with an earthquake having an annual probability of 1×10^{-3} or less would result in a sequence annual probability of 1×10^{-6} or less (below the Category 2 threshold).

In addition to direct seismic failures, some SSCs in the system FT could be vulnerable to failure by secondary system interaction effects (this type of failure is commonly termed "two-over-one" interactions in NPP seismic analyses). Such dependencies should be included in the fault tree model unless they are screened out as low probability events. If appropriate, unlikely seismic failure events may be screened out of the system fault trees.

For example, the SMAs of commercial NPPs apply guidelines for screening based on generic HCLPF capacities (given in terms of PGA) for various categories of components (Prassinos et al. 1986, pp. 18 to 21). However, for a BDBGM greater than 0.5 g, virtually no SSC can be screened out for the generic commercial NPPs (EPRI 1991, pp. 2-37 to 2-41).

The fault tree models are solved to determine the minimal cutsets that result in the top event. Minimal cutsets define the individual failure events or combinations of failure events that could each result in the occurrence of the top event. A cutset may include one or more independent failures, a seismic failure event and one or more independent events, or multiple seismic failure events.



NOTE: [1]. Event labels are defined in Appendix V

Figure II-4. Fault Tree: Crane or Fuel Handling Machine Fails to Maintain Suspended Load

Simple fault trees like those in the present analysis can be solved by hand using the rules of Boolean algebra. More complex fault trees may require a specialized program such as the SAPHIRE program (Smith et al. 2000).

II.5 Development of an Overall Boolean Expression

The cutsets for individual sequences having the same consequences are combined into a facility-wide Boolean expression. For the this evaluation, the minimal cutsets of all seismic event sequences that result in an offsite dose of 5 rem TEDE or greater are combined through the logic of the MLD. The laws of Boolean algebra are applied so that many cutsets containing the same failure event, either seismically-induced or independent failures, are absorbed into the lowest order cutset containing that failure event.

The result is the final Boolean expression for the top event that is being considered (e.g., a single sequence or the sum of several sequences that give an offsite dose of 5 rem or more). The final Boolean expression is used to calculate the HCLPF capacity for the repository as a whole, using HCLPF capacities of individual SSCs as inputs, as described in Section II.6.

II.6 Evaluation of HCLPF Capacities of SSCs

A HCLPF capacity is tied to a specific seismic failure event, or loss of a specific safety function, for a given SSC. Thus, the structure of a transfer cell may have two safety functions that could be credited in the prevention or mitigation of seismic event sequences. One safety function might be “no collapse” (onto staged CSNF assemblies or DOE canisters) to prevent a release. Another safety function of the structure might be “maintain confinement” if the structure is necessary to ensure mitigation succeeds. Because of strength margins ensured by designing SSCs ITS in accordance with nuclear precedents, the HCLPF capacity for maintain confinement will be significantly greater than the DBGM level for which the structure is designed. Furthermore, the HCLPF capacity for no collapse will be even higher and, therefore, will be significantly greater than the DBGM level

The HCLPF capacity of mechanical equipment is also defined for the loss of safety function. For transport vehicles, the loss of safety function includes an uncontrolled speed, a tipover or a failure of the waste form restraints that results in an impact to a waste form that exceeds its design basis. For cranes and fuel handling machines, one loss of safety function is dropping a waste form beyond its design basis, and another is failure of the equipment supports that results in a fall of heavy equipment onto a waste form.

When design detail permits, HCLPF capacities are provided by design and structural engineering as input to the seismic systems analysis. For such analyses, HCLPF capacities specific to designs of repository SSCs ITS will be calculated using the CDFM method (EPRI 1991, pp. 2-45 to 2-55). For this preliminary calculation, however, generic capacity factors are used to estimate representative HCLPF capacities in a CDFM framework.

II.7 Seismic Margins Evaluation

II.7.1 Objective

The objective of the SMA is to demonstrate that there is a suitably low conditional probability of an unacceptable dose, given an earthquake of the magnitude of the BDBGM level.

II.7.2 Determination of HCLPF Capacity for Repository

The HCLPF for the repository is calculated through a max-min treatment of the combinations of HCLPFs of the individual SSC according to how the SSC appears in the AND and OR logic or the facility-wide Boolean expression. The facility-wide Boolean expression is derived from the event tree and fault tree analyses. When two or more SSC seismic failure events appear in an AND expression (i.e., the intersection of two or more events), the HCLPF acceleration for the expression is the *maximum* HCLPF capacity of one SSC appearing in the Boolean expression. When two or more SSC seismic failure events appear in an OR expression (i.e., the union of two or more events), the HCLPF acceleration for the expression is the *minimum* HCLPF capacity of one SSC appearing in the expression. This method is in accordance with *Recommendations to the Nuclear Regulatory Commission on Trial Guidelines for Seismic Margins Reviews of Nuclear Power Plants* (Prassinos et al. 1986, Section 4.8.2).

If the expression is simple enough, the evaluation of the facility-wide HCLPF using the min-max process may be performed by hand. Otherwise, a event tree/fault tree computer program, e.g., SAPHIRE (Smith et al. 2000), may be used to develop the SET, fault trees, the minimal cutsets for individual sequences, and the facility-wide Boolean expression for the top event (i.e., a release that exceeds the 10 CFR 63.111 offsite dose limit).

The facility-wide HCLPF capacity is the smallest ground motion acceleration that could result in a dose that exceeds the regulatory limits. If all of the SSCs appearing in the repository-wide Boolean expression have a HCLPF acceleration that is higher than PGA_{BDBGM}, the smallest acceleration that could result in a non-compliant dose would also be higher than PGA_{BDBGM}. The repository would be deemed to have achieved HCLPF, i.e., a high confidence of low probability of failure to comply with 10 CFR Part 63.

For example, suppose a facility is subject to four seismic failure events labeled A, B, C, and D, and that a dose of 5 rem could occur from the following minimal cutsets: {A}, {B}, or {C, D}. Events A through D represent various losses of safety functions of one or more SSCs. The mathematical set {C, D} (the term, “set,” in this context should not to be confused with a “SET”) means that both seismic failure C and seismic failure D must occur to produce the release of radiation. The sets {A} and {B} each contain a single element, meaning that if either event A or event B is true, there would be a release. The Boolean expression for the event T, “seismic failures result in dose of 5 rem” is given as the logical union (summation) of all minimal cutsets that produce the same outcome.

In the current example, the Boolean expression becomes:

$$T = A + B + (C*D)$$

For illustration, suppose that the HCLPF capacities of the events A, B, C and D (represented as H_A, H_B, H_C, and H_D, respectively) have been determined to be H_A = 0.8 g, H_B = 1.0 g, H_C = 0.5 g and H_D = 0.7 g. These values are applied in the Boolean expression using the min-max approach to determine the HCLPF capacity for the facility $H_{T,}$ as follows:

$$H_T = \min\{H_A, H_B, \max[H_C, H_D]\},$$

$$H_T = \min\{0.8\text{ g}, 1.0\text{ g}, \max[0.5\text{ g}, 0.7\text{ g}]\},$$

$$H_T = \min\{0.8\text{ g}, 1.0\text{ g}, 0.7\text{ g}\},$$

$$H_T = 0.7\text{ g}.$$

This example illustrates how the failure mode with the lowest HCLPF capacity determines the overall HCLPF capacity for the facility.

ATTACHMENT III
IDENTIFICATION OF SEISMICALLY-INITIATED POTENTIAL EVENTS

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ATTACHMENT III

IDENTIFICATION OF SEISMICALLY INITIATED POTENTIAL EVENTS

The identification of operations and waste form(s) at risk together with potential events that can be seismically initiated are presented in Tables III-1 and III-2, based on the results of the internal hazards analysis (BSC 2004p) and the identification and review of other potential seismic hazards. Facilities discussed in the section are identified in Attachment I.

In Table III-1, columns 1 through 4 are summary materials, as follows:

- Column 1 lists the functional areas.
- Column 2 summarizes the operations performed on radioactive waste forms in each area. An area such as the equipment maintenance warehouse is noted as "N/A" for not applicable since no waste forms will be handled there.
- Column 3 lists the SSCs (other than structures) that are used in the various operations. The SSCs listed are not necessarily ITS unless they are credited with prevention or mitigation of an event sequence.
- Column 4 characterizes the waste form and quantity of material at risk that could be involved in an event sequence initiated by a seismic event.

In Table III-2, columns 2 through 3 identify seismic sequences:

- Column 1 lists the functional areas.
- Column 2 lists the potential initiators of seismic event sequences that were considered in the internal event hazards as a potential initiator of internal event sequences for each functional area of the repository. The initiating events in this column are primarily derived from the internal hazards analysis (BSC 2004p). However, hazards for the SNF Aging System are based on guidance from Cogema (2004), as cited in BSC (2004p). The results of these two analyses were screened to identify hazard categories that involve collisions or crushing of waste forms or fire initiation in waste handling or staging area. Column 2 provides a starting place for the seismic safety analysis by building on previous analyses.
- Column 3 is created as part of this seismic analysis to identify initiating events that could be initiated only by an earthquake, such as the collapse of the structures housing the operations.

In review of the internal hazards list in BSC (2004p), some internal hazards were excluded as not credible as regard to seismically-initiated event sequence. These hazards were screened-out due to an expected small occupancy or exposure factor that reduces the probability of a specific event (in conjunction with an earthquake) to a very low probability of occurrence (i.e., less than

1×10^{-3}). Therefore, these hazards are not included in Table III-2, based on the present level of design information.

These screened-out hazards include:

1. "Non-intact SNF oxidation or oxidation of damaged SNF and degradation due to exposure to a non-inerted environment at normal operating temperatures" under topic, "Chemical Contamination/Flooding."

2. The three hazards under the topic, Explosion/Implosion, including, "hydrogen explosions," "explosion hazard associated with the cask sampling and purging system," and "pneumatic or pressurized system missile due to a fractured nozzle/valve stem/pneumatic device."

3. "Cask overheating due to solar insolation."

Updates to this analysis will re-evaluate the screening of these hazards as design information evolves.

Table III-1. Identification of Operations and Waste Form(s) at Risk

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
1. Transportation Facility: 1. Railcar Staging Area 2. Truck Staging Area	Move casks on commercial transporters	Commercial transporter (Locomotives, railcars, trucks, and transfer trailers)	Transport casks - With Impact Limiters - Quantity Varying With Time.
2. Receipt Systems: 1. Cask and Waste Package Receipt Building (CWPRB), containing: • Cask Receipt / Return Area of the Transportation Cask Receipt Return Facility (TCRRF) and • Warehouse & Non-Nuclear Receipt Facility (WNNRF), 2. Transportation Cask Buffer Area (TCBA) of the TCRRF	Receive, inspect, move, park, and queue transporters with casks Lift, rotate and transfer casks Transport casks with DPC to SNF Aging	Site prime mover Site-rail transfer cart (SRTC) SRTC positioner SRTC tractor Rail lines for the SRTC Commercial transporter (Locomotives, railcars, trucks, and transfer trailers) 250 ton overhead crane Mobile elevating platforms Forklifts Turntable (located between the CWPRB and the TCBA) 25 ton Maintenance crane Grapples and support stands Cask/skid lifting yokes Impact limiters Horizontal cask transfer trailer Locking device - SRTC	Transport casks - with impact limiters (impact limiters and personnel barriers may be temporarily removed) • Up to 30 casks in TCRRF Transportation Cask Buffer Area • Maximum of 4 Casks in TCRRF Cask Receipt / Return Area

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
3. CHF: ***Cask Receipt*** Entrance Vestibule, Tools/Parts Storage Room	Open roll-up entry doors Move cask into entrance vestibule Close roll-up entry doors Remove impact limiters and personnel barrier using crane Inspect/survey for contamination, radiation, and for damage Open doors, move into tools/parts storage area Close doors Open canister transfer cell shield doors	SRTC Airlock doors Commercial transporter (Locomotives, railcars, trucks, and transfer trailers) 20 ton vestibule bridge crane Forklifts Scissor jack Shield wall and door Personnel barrier Mobile elevating platforms	Transport cask - With Impact Limiters; Transport cask (DPC) - Without Impact Limiters
4. CHF: ***Canister Transfer*** Canister Transfer Cell	Move cask into the shielded canister transfer cell. Remove cask tie-downs and upend cask on the SRTC, LWT trailer, or OWT trailer using the 200 ton capacity bridge crane. Lift cask and position into the cask preparation pit utilizing the 200 ton overhead bridge crane. Position a moveable platform for cask and MSC preparation over the pit to provide worker access for lid bolt removal and gas sampling operations. Sample cask interior cavity gas contents, and if normal, equalize the internal pressure, and remove the cask lid bolts. In the unlikely event a gas sample indicates that the cask contains a breached canister, the cask is removed to the Remediation Facility, if available, or other holding area. Transfer the moveable platform for cask and MSC preparation to the staging area in the canister transfer cell. For DOE transportation casks, the lid is left in place until the transfer system is ready to commence transfer operations.	Shield walls, and doors Shield view ports Manipulators Tie-downs (seismic restraints) Lifting Yokes WP transfer trolley Shield ring and lifting grapples SRTC MSC transporter Locomotives, railcars, trucks, and transfer trailers Remote-control lid bolt detorquers Handling equipment Trolley travel locks	Transport cask - With Impact Limiters Transport cask (DPC) - Without Impact Limiters (2) Open WP's / MSC's (1) Transportation cask (unloading pit) (10) Canisters in staging pits

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	For naval transportation cask preparation, remove the cask lid and install a shield ring over the pit to provide shielding over the annulus area between the pit and cask wall. If SNF or HLW aging or staging is required, transfer a canister to an MSC for transfer to the SNF Aging System. When an empty MSC is scheduled for processing, Transport the MSC from either the WNNRF or an aging pad and move through the entrance vestibule to the canister transfer cell. Remove tie-downs, and lift the empty MSC and position into the MSC/WP loading pit, and prepare for canister transfer. Transport the WP from the WNNRF to the CHF using an SRTC. The WP middle and outer closure lids are delivered to the WP closure support area. Move the empty WP and inner lid with spread ring from the SRTC using the 100 ton capacity overhead bridge crane to the MSC/WP loading pit. When aging is required, move empty MSCs from the WNNRF on the SRTC. Lift and position the WP is into the MSC/WP loading pit where it is prepared to receive canisters. The cask preparation pit and the MSC/WP loading pits are equipped with impact limiters to absorb and dissipate impact energy from an accidental drop of a loaded WP, and to mitigate canister damage and prevent a breach of a DOE standardized canister or an MCO. Perform canister transfer operations in the canister transfer cell. Once the WP is prepared to accept canisters with the inner lid removed, personnel exit the canister transfer cell. Operators remotely remove the lids from the DOE transportation casks or MSCs, or they remove the shield ring from the naval transportation cask. Remote operations are performed from the canister transfer cell operating gallery.	(Continued from prior page) Cask outer lid Pit moveable platform MSC inner and outer lids 100 ton auxiliary hook and torque wrench Impact limiters 200 ton cask handling (bridge) crane 100 ton WP and canister handling crane Cask preparation pit (2) MSC/WP pits Canister staging pit WP turntable WP tilting machine WP collar removal machine MSC transporter Shield plugs	See Prior Page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	Position the 100 ton capacity WP and canister handling crane over the pit and use a canister lifting grapple to engage and lift each canister one at a time. Lift canisters out of the cask using the remotely operated overhead crane. The canister is lifted slightly above the floor and moved to a location over the prepositioned WP in the MSC/WP loading pit. Remotely disconnect the canister grapple, and return the crane to a staging position. For DOE SNF and DOE HLW canisters, several transfer operations from one or more transportation casks are required to fill the WP. In the case where DOE SNF and HLW canisters are not to be immediately loaded into a WP, transfer operations are performed to move a canister into the canister staging pit or an MSC. NSNF canisters require one transfer to load the canister into the naval WP. Prior to removing the naval transportation cask shield ring, a lift fixture with pintle is lowered over the NSNF canister. The lift fixture with six captive bolts is manually attached to the NSNF canister. Prior to canister transfer operations, personnel are evacuated from the canister transfer cell and the cask shield ring is removed. Lower the grapple of the 100 ton crane to remotely engage with the pintle on the lift fixture. Lift the canister and transfer to either a naval long WP or naval short WP, as appropriate to the NSNF canister being handled. Lower the 100 ton crane auxiliary hook, attached with a remotely operated torque wrench and disconnect the canister-lifting fixture. Remotely transfer (using the main hook with grapples) the lift fixture to a staging area in the canister transfer cell. Place the inner lid and spread ring in the WP to prevent canister ejection due to an accidental drop. The WP is then ready for transfer to the WP trolley and WP positioning cell for closure operations.	See Prior Page	See Prior Page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	An MSC is capable of receiving a vertical DPC for aging. Place the empty MSC in an MSC/WP loading pit, loosen and remove lid bolts, and lift the he lid away. Place a transportation cask containing a DPC in the adjacent MSC/WP loading pit and remove the lid bolts and closure lid(s). Personnel will manually install a canister-lifting fixture with pintle and exit the transfer cell. The transfer of the DPC to the MSC is performed remotely. Personnel then reenter the canister transfer cell, reinstall the MSC lid, and load the MSC onto the SRTC for delivery outside to an MSC transporter for transfer to the SNF Aging System. Transfer the unloaded transportation cask to the cask receipt and return system.	See Prior Page	See Prior Page
5. CHF: ***WP Transfer to WP Closure, MSC Closure and Removal*, *Canister Transfer Cell***	Remotely engage a loaded WP with the 100 ton capacity WP and canister handling crane, lifting yoke, and WP upper lifting collar; lift out of the pit, and place on a WP trolley. Move WP trolley a WP positioning cell and the WP trolley parking area located outside the WP positioning cell. Using remote controls, shield windows, closed-circuit television, manual and power manipulators, remotely controlled overhead bridge cranes, and other remote equipment, perform the SNF and HLW canister transfer operations. After loading an MSC, personnel then reenter the canister transfer cell, reinstall the MSC lid, and load the MSC onto the SRTC for delivery outside to an MSC transporter for transfer to the SNF Aging System. Move MSC outside on an SRTC where an MSC transporter can retrieve the cask for transfer to an aging pad. For an MSC containing a vertical DPC, remove the lift fixture with pintle prior to the MSC lid being installed. Loaded MSCs also go through additional processing steps, including filling the cask with an inert gas and performing seal leak tests, as necessary	See CHF: Canister Transfer Area - Canister Transfer Cell + Remote equipment including: remote controls, shield windows, closed-circuit television, manual and power manipulators Lift fixture with pintle	See CHF: Canister Transfer Area - Canister Transfer Cell

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
6. CHF: ***WP Closure***	Install inner lid spread rings on WP Weld inner lid and spread ring Evacuate WP interior and fill with inert gas Weld middle and outer lids Examine welds and mitigate residual stress	WP transfer trolley 15 ton and 3 ton precision handling cranes Robotic arm Shield door(s) Electromechanical manipulators Glove box Shield view port Trolley pedestal Welding equipment WP inner, middle and outer lids WP spread ring Trolley rail tracks Handling equipment	Two unsealed WPs
7. CHF: ***WP Loadout*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule	Open shield doors and move WP transporter into WP loadout area from WP closure cell through WP tool storage room using transport locomotive Open WP transporter doors and extend bedplate Lift and position WP Survey for contamination and defects Lower onto emplacement pallet, which is on rotating table Reposition WP by using rotating table Remove lifting collars Lift, transfer and lower WP and emplacement pallet onto WP transporter bedplate Retract bedplate and close WP transporter doors Move WP transporter out of CHF through WP tool room and exist vestibule; close shield doors using transport locomotive	Shield doors 100 ton loadout cell bridge crane WP Lifting collar and yoke Emplacement pallet WP transporter Transport locomotive(s) Tilting fixture Rotating table Trolley pedestal Transporter rail tracks	One full, sealed WP

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
8. CHF: ***Empty Transportation Cask and MSC Removal*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule	None (Tasks involve unloaded casks, and unloaded MSCs)	N/A [d]	N/A
9. DTF: ***Cask & MSC Receipt*** Cask and MSC Entrance Vestibule, Cask and MSC SRTC Receipt Area, Cask and MSC to Trolley Transfer Room	The SRTCs carrying loaded transportation casks with impact limiters installed are received in the cask and MSC SRTC receipt area of the DTF after passing through the cask and MSC entrance vestibule. *Operations:* Open shield doors and move casks into vestibule area Close shield doors Remove impact limiters and personnel barrier Perform inspection and radiological survey Open airlock doors Lift and upend the transportation cask using the cask handling crane. Vertically move cask from the cask and MSC SRTC receipt area through a shield door and into the cask and MSC to trolley transfer room. Place the cask on the pedestal on the trolley and secure in place with hold-down devices. The MSCs to be unloaded in the DTF are prepared for transfer operations in a manner similar to that used for CSNF transportation casks and in the same locations Loaded MSCs processed in the DTF are carried to the DTF by the MSC transporter from the SNF Aging System pad and lowered onto an SRTC (in a vertical orientation) outside of the DTF. The SRTC holding the MSC is then pushed by an SRTC tractor into the DTF for processing.	200 ton cask handling crane 25 ton impact limiter crane Seismic restraints SRTC 10 ton forklifts Shield/entrance doors Handling tools Personnel barriers Impact limiters Mobile elevating platforms Transfer trolley MSC transporter SRTC rail tracks Transfer trolley tracks Yokes, yoke stands and restraints Trolley pedestal	One sealed transport cask without impact limiters (one cask per DTF) Or sealed MSC

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
10. DTF: ***Preparation*** Cask/MSC Turntable Room, Cask Preparation Room	Close airlock/shield doors to receipt room. Open airlock/shield doors to turntable room Cask and trolley moves into turntable room onto rotating table Close airlock/shield doors to transfer room. Cask is rotated to align with preparation room entrance Open airlock/shield doors from turntable to preparation room Cask and trolley moves into preparation room Close airlock/shield doors from turntable to preparation room Outer lid bolts removed Gas sampling and pressure checks performed Outer lid removed Inner lid bolts loosened and some removed Install docking rings	Airlock/shield doors Turntable Transfer trolley Remote-control lid bolt detorquers Tools and equipment (including a lid-lifting fixture, lid bolts, etc.) Outer and inner lids Trolley tracks Trolley pedestal	One sealed transport cask without impact limiters or MSC (one per DTF) [During last stages: One partially unsealed transport cask without impact limiters or partially unsealed MSC (one per DTF)]
11. DTF: ***Cask and MSC Docking*** Cask and MSC Docking Room	Open airlock/shield doors to turntable room Move cask and trolley into turntable room onto rotating table Close airlock/shield doors to preparation area Rotate cask to align with docking room entrance Open airlock/shield doors from turntable to docking room Move cask and trolley into docking room and unto turntable Rotate cask to align with docking position Move cask to position under docking port Close airlock doors from turntable room to docking room	Airlock/shield doors Turntable Transfer trolley Trolley rail tracks Trolley positioning equipment Cask inner lid Trolley pedestal Docking rings Gantry crane Mobile slab and cell plug	One partially unsealed transport cask without impact limiters (one cask per DTF)

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
12. DTF: ***Empty WP and MSC Processing Prior to Loading***	None (Tasks involve unloaded WPs)	N/A [d]	N/A
13. DTF: ***NSNF Receipt*** WP and Navy Cask Entrance Vestibule, WP/Navy Cask SRTC Receipt Area, WP/Navy to Trolley Transfer Room, WP/Navy Cask Preparation Room	NSNF casks enter the DTF on SRTCs in the WP and navy cask entrance vestibule and are unloaded in the WP/navy cask SRTC receipt area. *Operations:* Open shield doors Move casks into entrance vestibule area Close shield doors Remove impact limiters and personnel barrier using WP handling crane and place on special stands for radiological survey Perform inspection and radiological survey Open airlock doors Lift, tilt and vertically load cask through shield doors onto trolley using the 200 ton navy cask handling crane Place seismic restraints placed on cask Move trolley and cask to the WP/navy cask preparation room	10 ton forklift 200 ton naval-cask handling crane 50 ton WP handling crane Transfer trolley Seismic restraints SRTC tractor Mobile elevating platforms Handling equipment SRTC rail tracks Trolley rail tracks Trolley positioning equipment Trolley pedestal Shield doors Lid bolts	Sealed NSNF cask without impact limiters

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
14. DTF: ***NSNF Processing*** WP Docking Cell, WP Loading (Naval Canister)/Docking Ring Removal Cell, WP Loading/Docking Ring Removal Cell	Open shield doors Move cask into preparation room Close shield doors Sample interior gases of cask Remove lid bolts Move trolley and cask to the naval cask transfer room Lift and position the naval cask through the WP docking cell to the WP loading (naval canister)/docking ring removal cell under the unloading station. Transfer the canisters using a special crane to an empty WP previously placed in the WP loading/docking ring removal cell. Thereafter, prepare WP for transfer to the WP handling and staging cell, including placing the inner lid on the WP.	Airlock/shield doors Cask outer lid Transfer trolley 70 ton Navy Cask handling crane Remote-control lid bolt detorquers Handling equipment (such as a canister grapple) Trolley rail tracks Trolley positioning equipment Trolley pedestal Lid bolts	One unsealed NSNF cask without impact limiters (one cask per DTF)

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
15. DTF: ***Transfer*** Cask and MSC Docking Room, Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell	Remove cask inner lid and/or docking port plugs Select grapples and index cask/MSC/ to be unloaded Initiate auto transfer by spent fuel transfer machine Check cask/MSC after transfer Undock unloaded cask/MSC, open docking room doors, and then transfer cask/MSC to restoration area Check WP and install inner lid Undock WP, open docking room doors, and move WP by trolley to WP closure preparation cell	Spent fuel transfer machine Various grapples Transfer trolley Airlock/shield doors Staging racks Inner WP lid 70 ton Navy Cask handling crane WP loading/docking ring Mobile slab Handling equipment (such as a canister grapple) Trolley rail tracks Trolley positioning equipment Trolley pedestal Lid bolts Shield view ports/windows Manipulators	Open WPs or MSCs (2 stations) Two open transport cask s or two open MSCs or one of each SNF assembly or canister Staging racks • 120 CSNF assemblies • 10 canisters
16. DTF: ***Empty Transportation Cask/ MSC/DPC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Restoration Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule	Once SNF/HLW transfer operations are completed, retrieve the transportation cask inner lid from storage in the waste transfer cell and lower into the unloaded cask. Place the docking port plug into the docking port and disengage the cask port docking device. Return unloaded transportation casks (except naval transportation casks) and loaded or unloaded MSCs to the Cask/MSC/WP Preparation System from the SNF/HLW Transfer System following waste transfer operations. Undock unloaded transportation casks and loaded or unloaded MSCs room the cask and MSC docking room or the DPC Docking room. Move the cask trolley to the cask restoration room.	Cask inner lid Docking port plug Cask trolley Docking ring, 200 ton cask handling crane Cask tie downs Impact limiters and personnel barrier SRTC WP trolley 200 ton navy cask handling crane	Accumulated materials

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
16. DTF: ***Empty Transportation Cask/ MSC/DPC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Restoration Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule (Continued)	Remove and decontaminate docking ring, and send it back to the cask preparation subsystem. Fasten and check the inner lid for tightness. Install outer lid (depending on cask design). Conduct an external radiological survey on the cask, trolley, and pedestal. Move the cask trolley to the cask and MSC to trolley transfer room. From here, lift the unloaded transportation cask with the cask handling crane, place on the SRTC in the cask and MSC SRTC receipt area, and down-end back to a horizontal position. Install cask tie down, as necessary, and impact limiters and personnel barrier are installed, if necessary. Move the unloaded transportation cask through the cask and MSC entrance vestibule to the Cask Receipt and Return System on the SRTC. Return unloaded naval casks to the Cask/MSC/WP Preparation System by the SNF/HLW Transfer System. Set the cask lid in place and move the WP trolley from the WP loading (navy canister)/docking ring removal cell to the WP/navy cask preparation room. Install cask lid bolts and perform a radiological survey. Then move the naval cask to the WP/navy trolley transfer room, lift using the navy cask handling crane, place on the SRTC and down-ended to the horizontal position in the WP/navy cask SRTC receipt area. Install the naval cask tie downs are installed, as necessary, and perform a radiological survey. Install the impact limiters and personnel barrier, if necessary. Perform a second radiological survey and final inspection. Move the unloaded naval cask on the SRTC through the WP and navy cask entrance vestibule to the cask receipt and return system. Move unloaded DPC casks from the DPC docking room to the cask restoration room and are handled in a similar manner as that of other transportation casks during cask restoration operations.	See prior page	See prior page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
16. DTF: ***Empty Transportation Cask/ MSC/DPC Removal*** (Continued)	Move unloaded MSCs from the cask and MSC docking room to the cask restoration room and handle in a similar manner as that of other transportation casks.	See prior page	See prior page
17. DTF: ***Loaded MSC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Preparation Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule	Move loaded MSC and trolley onto docking turntable Rotate MSC to align with cask turntable room entrance Open airlock/shield doors to cask turntable room Move loaded MSC and trolley into turntable room onto rotating table Close airlock/shield doors to docking room. Rotate MSC to align with restoration room entrance Open airlock/shield doors from turntable to restoration room MSC and trolley moves into restoration room Close airlock/shield doors from turntable to restoration room Remove docking ring, and replace cask inner lid Restore MSC: vacuum dry, seal, fill with inert gas, test seals Open airlock/shield doors from turntable to restoration room Move loaded MSC and trolley into turntable room onto rotating table Rotate MSC to align with restoration room entrance Open airlock/shield doors from turntable to transfer room Move MSC into transfer room Transfer MSC to a MSC transporter and move MSC to Aging Facility (Specific activities are reverse of MSC load-in)	Transfer trolley 200 ton cask handling crane SRTC Airlock/shield doors Shield view ports Docking ring MSC outer lid MSC inner lid Turntables MSC transporter Mobile elevating platforms	One partially-sealed MSC

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room	Conduct contamination survey Transfer WP from trolley to lateral transfer system trolley using crane Install inner lid Trolley moves WP laterally into WP closure cell Install inner lid spread rings Tack weld inner lid Purge WP interior/backfill with inert gas Weld middle and outer lids Inspect welds and postclosure check WP is transferred out of cell to storage area or remediation (if necessary)	100 ton staging cell overhead bridge crane WP Transfer Trolley Lateral Transfer Trolley Closure cell pedestal Welding equipment Inner, middle and outer WP lids Spread ring Shield doors Manipulators Glove box facilities Shield view port(s) / windows Handling equipment Grapples and yokes Trolley rail tracks	One full unsealed WP prior to transfer into closure cell (4 stations per DTF); sealed thereafter

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
19. DTF: ***WP Loadout*** WP Loadout Cell, WP Transporter Vestibule, Exit Vestibule	Configured tilting machine for WP Type Lift/move WP with crane onto trolley and mount Move trolley into loadout tilt and transporter area Rotate WP to horizontal using titling machine Lower WP onto emplacement pallet with loadout handling crane Remove trunnion collars Move and dock the subsurface transporter into DTF, and extend bedplate Lifts, transfer and lower WP and emplacement pallet with crane onto WP transporter bedplate	100 ton WP loadout cell overhead crane Tilting machine WP loadout trolley Four-point lifting fixture (for engaging pallet) Emplacement pallet WP transporter WP Trunnion collars Rotating table Shield doors Manipulators Transport locomotive(s) Trolley rail tracks WP transporter rail tracks	One full, sealed WP in process (one per DTF)
20. DTF: ***WP Remediation*** DPC Cutting/WP Dry Remediation Cell	Open shield doors Transfer loaded, sealed WP from WP closure area to cutting WP dry remediation cell on WP trolley Close shield doors Lift WP into opening station inside WP dry remediation cell If necessary, open WP by cutting machine, and place docking interface on WP (including lid cover) Place WP on trolley and move to DPC/WP unload port Remove inner lid and open WP Transfer contents to staging area or to new WP or to MSC using spent fuel transfer machine	WP trolley Handling tools Chip-less Cutting machine 100 ton WP remediation (bridge) crane Docking interface WP lids Shield doors Spent fuel transfer machine Shield view port(s) Shield doors Trolley rail tracks Manipulators	One full, sealed or open WP in process (one per DTF) During transfer: one of the following: • Fuel assemblies • DSNF / HLW Canisters • NSNF canisters During transfer: one of the following: • Open WP • Open MSC • CSNFA staging racks

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations [a,c]**	**Identified Relevant SSCs [b]**	**Expected Waste Form and Material at Risk**
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell	Open/close shield doors for DPC Preparation Room, DPC Docking Room, and Tool Spare Transfer Room as required for movement. *Off-Normal condition detected in the Cask/MSC/WP Preparation System:* Move transportation cask or MSC (or containing the waste necessitating remediation) from the Cask Preparation Room through the DPC Preparation/Cask Dry Remediation Room to the turntable in the DPC Docking Room. From the turntable, move the cask to the Tool / Spare Storage Room When applicable, repair the transportation cask or MSC, and return it to the Cask Preparation Room to finish cask preparation. If necessary, move the cask back into the Cask Dry Remediation Docking Room and docked for waste remediation. Transfer the SNF/HLW from the cask to a basket located on a WP/DPC trolley in the DPC cutting/WP dry remediation cell using the WP remediation crane. Move the basket on the WP/DPC trolley to the DPC/WP unload port. Open sliding door and transfer to a WP by the SNF/HLW Transfer System. Undock cask in the Cask Dry Remediation Docking Room Move cask to the Tool/Spare Storage Room for restoration. After restoration, return cask on its trolley to the Cask/MSC/WP Preparation System for transfer to an SRTC. *When the off-normal condition affects SNF/HLW and the condition is detected during the SNF/HLW transfer process:* Undock and close the cask and closed, as appropriate, in the Cask and MSC Docking Room.	15 ton tool spare transfer room crane 100 ton WP remediation (bridge) crane Port plug gantry crane Handling tools Docking port (mobile slab) Docking port plug Shield doors Transfer trolley SRTC Docking ring Cask lid MSC outer and inner lids Turntable Basket on trolley Shield view port(s) Trolley rail tracks Manipulators Tools and equipment Handling equipment and grapples Mobile elevating platforms	During transfer: one of the following: • MSC or Transportation cask • SNF/HLW

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	(Continued from prior page) Move the cask on its trolley through the Cask/MSC Turntable Room, the Cask Preparation Room, DPC Preparation/Cask Dry Remediation, the turntable in the DPC Docking Room, and into the Cask Dry Remediation Docking Room and/or the Tool/Spare Storage Room. If necessary, remove the cask contents as previously described. Naval casks will not be transferred to DPC cutting / WP Remediation cell by this system.	See prior page	See prior page
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule	Transfer casks vertically on transfer trolley from DTF process area or horizontally on SRTC through entrance area *From DTF:* Open/close shield doors for DPC Preparation Room, DPC Docking Room, and Cask Wet Remediation / Laydown Area as required for movement. *From Outside:* Open/close roll-up and shield doors as required for movement. Move cask into wet remediation room Fuel transfer takes place under water. For horizontal cask, crane lifts and upends cask to vertical and then onto turntable inside cask pit Otherwise, crane transfers vertical cask to cask pit Prepare cask, including sampling and unbolting lids Lift and lower cask into pool by crane and grapple Open lid Fuel handling machine removes SNF and transfers SNF to staging rack, to MSC or to special canister Replace lid on empty cask, and lift cask from pool into cask pit and drain; place on trolley and move empty cask to Receipt Area	Transfer trolley 200 ton cask handling crane 20 ton overhead maintenance crane Cask handling equipment including lifting yoke SRTC Airlock doors Roll-up door Wet remediation fuel handling machine Pool structure (including fuel baskets and racks; (2) cask stands; crush pads; stainless steel liner) Pool water supply system (treatment and cooling; water-level control; ion exchange bed and filters; pumps; piping) Mobile elevating platforms	Loaded cask or MSC upon entry (one per facility) Staging racks / baskets (minimum total capacity): • 48 PWR CSNF assemblies • 72 BWR CSNF assemblies, • 10 DOE waste canisters After opening cask: During transfer: one of the following is present: • Fuel assemblies • DSNF / HLW canisters • NSNF canisters During transfer: one of the following is be present: • Open, full MSC • Open, special canister

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	(Continued from prior page) Move empty MSC to remediation area on trolley; lift/lower and place MSC onto turntable in cask pit and then to pool floor Transfer SNF from staging rack into empty MSC Install MSC lid and lift out of pool onto cask pit turntable Transfer MSC onto trolley and move loaded MSC to receipt area	(Continued from prior page) Remote-control bolt detorque machine Trolley rail tracks Shield view port / window Manipulators Handling tools and equipment External stairs/walkway in area Fuel assembly / cask drying equipment Lid storage racks Cask pit turntable SNF drying and inerting system Cask draining equipment Cask cooling equipment Cask equipment pits (2) Cask preparation and decontamination pit Cask lid(s) Cask skirt Turntable (inside the cask decontamination pit with electric motor)	See Prior Page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
23. DTF: ***DPC Cutting*** DPC Preparation/Cask Dry Remediation Room, DPC Docking Room, DPC Cutting/WP Dry Remediation Cell	Remove cask bolts Open shield doors to DPC preparation/cask dry remediation room Place DPC on trolley in cask receipt area, and move DPC cask by trolley to DPC preparation/cask dry remediation room Prepare cask by removing the cask lid, attaching a DPC handling device and installing the cask docking ring Following preparation, open shield doors and move cask and trolley into the DPC docking room. Position trolley under the DPC docking station to facilitates the transfer of the DPC from the cask to the DPC cutting/WP dry remediation cell Transfer the DPC from the DPC cask to the DPC cutting/WP dry remediation cell, using the WP remediation crane. Move the DPC into the DPC cutting station and sample internal gases and vent Remove DPC lid using the chipless cutting machine. Raise the severed lid high enough for a power shear to reach in and cut off the long drainpipe that was used during the loading of the DPC Remove DPC lid and transfer the DPC onto the WP/DPC trolley by the WP remediation crane Transfer the opened DPC on the trolley to the DPC/WP unload area of the DPC cutting/WP dry remediation cell for the transfer of the CSNF. Transfer CSNF to staging area or to WP or to MSC using spent fuel transfer machine After unloading is complete, return the WP/DPC trolley with the empty DPC to its initial position.	Transfer trolley Handling equipment Airlock doors Turntable (in DPC docking room) Cask docking ring Docking port plug 100 ton WP remediation crane Chip-less cutting machine Detorquing device Grapples Spent fuel transfer machine Cask lid and bolts DPC lid Trolley rail tracks Shield view ports and windows Manipulators Mobile slab	Sealed/unsealed, loaded DPC CSNF assembly (during transfer by spent fuel transfer machine)

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
24. FHF: ***Cask and MSC Receipt*** Entrance Vestibule	Open entry doors *Cask:* Move cask into area using diesel-powered site prime mover Close entry doors Off-load cask Remove impact limiters and personnel barrier using crane Inspect/survey for contamination, radiation, and for damage Up end, lift and transfer cask to import/export trolley *MSC:* Transport loaded MSC into entrance vestibule by MSC transporter. Inspect and then lift and transfer to import/export trolley	Site prime mover SRTC Locomotives, railcars, trucks, and transfer trailers 200 ton gantry crane 30 ton auxiliary hook Grapples, spreaders, bales, yokes and accessories Forklift Impact limiters Tilting frame Mobile elevating platforms Import/export trolley Entry doors (bypass leaf door) Rail tracks Cask preparation stand and tools	Transport cask - With Impact Limiters or Transport cask - Without Impact Limiters or MSC or Site-specific cask

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
25. FHF: ***Preparation*** Preparation Room	Open shield door Move casks (or MSC) into preparation area Close shield door Outer lid bolts removed Gas sampling and pressure checks performed Outer lid removed Inner lid bolts loosened and some removed Install docking rings Open shield doors to main transfer room, and move cask/MSC. Failed fuel is removed back through entrance vestibule o storage or Remediation Facility) Open shield doors to main transfer room, and move cask/MSC. Failed fuel is removed back through entrance vestibule o storage or Remediation Facility)	Site prime mover SRTC Import/export trolley Mobile elevating platforms Shield doors Rail tracks	Transport cask - Without Impact Limiters or MSC or Site-specific cask
26. FHF: ***Empty WP / Empty MSC Processing*** Entrance Vestibule, Preparation Room, Main Transfer Room, and Fuel Transfer Bay	None Identified (Tasks involve unloaded WPs and MSCs)	N/A [d]	N/A

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
27. FHF: ***CSNF Assembly Transfer*** Main Transfer Room, Fuel Transfer Bay, Fuel Transfer Room	Transfer the cask or MSC from the import/export trolley's pedestal to a pedestal on one of the three transfer bay trolleys using the main transfer room overhead bridge crane. Move the transfer bay trolley into the fuel transfer bay and beneath the fuel transfer room. Transfer CSNF using a fuel handling machine with a mast-mounted manipulator from a transportation cask or MSC into a designated WP or MSC via a dry handling process. After the fuel transfer activities are completed to an MSC, the shield lid is replaced. If a WP is loaded, place the inner lid on the loaded WP, and then reinstall the transfer port seal plugs. The loaded MSC, loaded WP, and empty cask or MSC are available for removal from the respective fuel transfer bays.	200 ton bridge crane 30 ton auxiliary hook Mobile elevating platforms, mobile slab Import/export trolley Transfer bay trolleys w. pedestal Shield doors and windows Rail and trolley racks Docking ring Spent fuel transfer machine 30 ton fuel transfer maintenance crane Manipulators Shield lid Wall penetrations (for swipes) Handling equipment	Transport cask - Without Impact Limiters or MSC or Site-specific cask Open WP (one) CSNF assembly (one)
28. FHF: ***Canister Transfer*** Main Transfer Room	Transfer the cask or MSC containing a canister or canisters to be unloaded into a WP or MSC into the main transfer room on the import/export trolley Remove the cask or MSC lid or lids, as appropriate, lift the canister or canisters from the cask or MSC and lower the canister(s) into the empty WP or empty MSC using the main transfer room overhead crane to the dedicated canister transfer station Once the transfer of the canister or canisters to the WP or MSC is complete, the respective lids are replaced on the cask, WP, or MSC prior to the dispositioning of the various filled and empty containers	200 ton bridge crane 30 ton auxiliary hook Mobile elevating platform Import/export trolley Closure trolley with pedestal Shield doors Rail and trolley tracks Docking ring Shield view port / windows Handling equipment Lids	Transport cask - Without Impact Limiters or MSC or Site-specific cask Canister (one) Open WP (one)

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
29. FHF: ***WP Closure*** Main Transfer Room, WP Positioning Cell, WP Closure Cell	Closure operations include welding, nondestructive examination, and stress mitigation Place the inner lid on a WP loaded with CSNF assemblies in fuel transfer bay Open the shield doors of the fuel transfer bay and move the trolley holding the WP into the main transfer room Remove the docking ring and transfer the filled, unsealed WP to the trolley that serves the WP closure cell using the main transfer room overhead crane Once the loaded WP is received in the closure cell, seal-weld the inner lid and spread ring in place, Evacuate the WP inner vessel and fill with inert gas Weld the middle and outer lids in place, and nondestructively examine the welds. Mitigate the residual stresses on the outer lid weld	Shield doors of fuel of transfer bay Welding equipment Inner middle and outer WP lids Spread ring Transfer trolley WP closure trolley 200 ton crane (main transfer room overhead crane) Docking ring Handling equipment Electromechanical manipulators Shield view port / windows Trolley tracks Glove box 15 ton closure cell crane 3 ton remote handling crane WP closure robotic arm Weld-stress mitigation equipment Inerting equipment Examination equipment	One full WP with no or partial seal

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
30. FHF: ***WP Loadout*** Main Transfer Room, Preparation Room, Entrance Vestibule	Once the WP is sealed, transfer the WP and trolley to the WP loadout area inside the main transfer room Lift the WP using the overhead bridge crane from the pedestal on the trolley and move to the WP survey area Remotely survey the loaded WPs for surface contamination and perform minor wipe downs of contaminated WPs utilizing remote manipulators Transfer the WP to the WP tilting machine using main transfer room overhead bridge crane Down-end the WP to a horizontal orientation using the WP upper and lower lifting collar trunnions and the tilting machine and over head crane Lower the WP onto the previously delivered emplacement pallet that is supported by the rotating table The rotating table is used to position the WP for remote removal of the WP upper and lower lifting collars using the lifting collar removal machine Move The WP transporter through the entrance vestibule and the preparation room to the transfer room WP loadout area Open the shield door(s) on the WP transporter and activate and the transporter bedplate remotely and extend it from the transporter Position the overhead crane and a lifting fixture with yokes over the WP and emplacement pallet. Engage the emplacement pallet and the WP using the lifting fixture Lift, transfer and lower the WP and emplacement pallet onto the extended WP transporter bedplate Retract the WP, pallet, and bedplate are into the WP transporter and close the transporter shield doors Move the WP transporter from the main transfer room, through the preparation room, and then through the entrance vestibule to the subsurface repository for emplacement	WP transfer trolley 200 ton crane (main transfer room overhead crane) Lifting collar Emplacement pallet WP transporter Shield doors Shield windows Manipulators WP upper and lower lifting collar trunnions WP tilting machine WP rotating table WP upper and lower lifting collars WP transporter rail tracks Trolley rail tracks Transport locomotive(s)	One full, sealed WP

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
31. FHF: ***Loaded MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule	After the MSC is filled, reinstall the MSC lid(s) and transfer the MSC to the import/export trolley, using the main transfer room overhead crane Perform a radiological survey, remove the docking rings and conduct other preparation activities Move the MSC on the import/export trolley to the preparation room where the MSC is prepared for exit Tighten MSC lid bolts fill with inert gas, and perform a leak test. Transfer the trolley and MSC to the entrance vestibule Open shield doors, move the MSC through the facility, and close shield doors After the MSC and trolley arrive in the entrance vestibule, lift the MSC from the pedestal on the import/export trolley using the gantry crane. Move the MSC in a vertical orientation to the pad outside of the FHF using the crane Lower the MSC using the gantry crane to the pad in a vertical orientation Lift the loaded MSC using the MSC transporter off the pad and transport it from the FTF to the SNF Aging System pad	MSC lid(s) Import/export trolley 200 ton bridge crane (main transfer room overhead crane) Shield doors 200 ton gantry crane (entrance vestibule gantry crane) Docking ring Lid bolts Trolley rail tracks Rail tracks MSC transporter Forklift Mobile elevating platform	Closed, loaded MSC
32. FHF: ***Empty Transportation Cask, MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule	Tasks involve unloaded casks and MSCs: For an unloaded cask/MSC in a transfer bay, retrieve the cask or MSC docking port plug with the attached inner lid from its storage area in the fuel transfer room and return it to the port Release the inner lid and return it to the cask or MSC cask. Disengage the port docking device and move the transfer trolley with the unloaded cask or MSC to the main transfer room Remove the docking ring, survey, decontaminate as necessary, and place onto a docking ring stand (or bag it for later decontamination)	Docking port plugs Inner and outer lids Transfer trolley Import/export trolley Docking ring Truck or rail conveyance Cask tie downs Gantry crane SNF Aging System transporter 200 ton gantry crane	None

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
32. FHF: ***Empty Transportation Cask, MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	For a cask or MSC unloaded at the canister transfer station, remove the protective collar. Lift the cask or MSC from the transfer bay trolley, or the floor of the main transfer room, and move to the import/export trolley. Move the import/export trolley to the preparation room. Bolt the inner and outer lids in place Inspect the unloaded cask or MSC for external damage, inspect sealing surfaces and swipe, survey and decontaminate (as necessary) external surfaces and move to the entrance vestibule (room 1001) For an unloaded cask, move an unloaded truck or rail conveyance from the appropriate staging area near the site security gate into the entrance vestibule. Move the unloaded cask from the cask transfer trolley to the conveyance and down ended in place. Secure cask tie downs in place, and install cask impact limiters, tamper indicating devices and personnel barrier Remove the unloaded transportation cask from the FHF for return to the National Transportation System. Move an unloaded MSC just outside the entrance vestibule using the gantry crane. The SNF Aging System transporter picks up the unloaded MSC and returns it to the SNF Aging System aging pad	See prior page	See prior page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
33. Subsurface: ***Subsurface WP Transport and Emplacement***	Receive WP on emplacement pallet onto bedplate, and retract bedplate into shield; close shield doors Transport WP to North Portal (surface), then down ramp, through mains to designated turnout Open ventilation isolation doors WP transporter car and locomotive positions shield at emplacement dock Close ventilation isolation doors WP transporter moves into transfer dock and WP transporter car opens shield doors Transfer WP to bedplate by chain mechanism WP emplacement gantry moves over bedplate and lifts and emplacement pallet Gantry moves WP and emplacement pallet in emplacement drift and sets them down in drift	WP transporter Transport locomotive WP emplacement gantry Ground support system Ventilation isolation doors Rail system and catenary system Emplacement pallet	One full, sealed WP in process (one per DTF and one per transporter) Other emplaced WPs
34. SNF Aging System; ***Aging Pads***	*Vertical Bolted-Closure Cask Operations:* • Engage and lift MSC using MSC transporter • Move the MSC to the Aging Pad using the MSC transporter over the transfer route • Move the vertical cask to the designated storage system on the pad, using the MSC transporter • Set the vertical cask down on the pad • Install/connect seal leakage monitoring system, as necessary • Conduct periodic inspections *Horizontal Aging System Operations:* • Attach the site tractor to the transfer trailer containing the HTC	Aging pad for vertical casks Horizontal aging modules (HAMs) MSC transporter Prime mover and transfer trailer Shield doors Mobile crane Horizontal storage module cart Horizontal cask transfer trailer Hydraulic rams Hydraulic power units closure plate HTC closure lid	One DPC per trip to horizontal aging module One MSC per trip to aging pad Multiple DPCs in aging module Multiple MSCs in vertical orientation on aging pad

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	Synopsis of Waste-Related Operations [a,c]	Identified Relevant SSCs [b]	Expected Waste Form and Material at Risk
34. SNF Aging System; ***Aging Pads***	*Horizontal Aging System Operations (Continued):* • Move the HTC to the Aging Pad • Position the HTC and transfer trailer in front of the module face • Remove the cask ram closure plate • Install the ram trunnion support assembly • Remove the HAM shield door • Use trailer skid positioning system / optical surveying transits to align cask with HAM • Remove the HTC top closure lid • Dock the HTC with the HAM and install the cask/module restraints • Install and align the hydraulic ram cylinder in the ram trunnion support assembly • Extend the ram hydraulic cylinder until the grapple contacts the DPC bottom • Engage the DPC grapple ring with the ram grapple • Extend the ram hydraulic cylinder until the DPC is fully inserted in the HAM • Disengage the grapple from the DPC • Remove the hydraulic ram from the HTC • Remove the HTC from the HAM • Install the DPC seismic restraint and HAM shield door	See prior page	See prior page

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations [a,c]**	**Identified Relevant SSCs [b]**	**Expected Waste Form and Material at Risk**
35. Subsurface Facilities: ***Construction Hazards***	None	Subsurface bulkheads Isolation airlocks/barriers Shafts Exhaust tunnels	WP(s)
36. Surface Facilities: ***Construction Hazards***	None	Commercial transporter (Locomotives, railcars, trucks, and transfer trailers) WP (shielded) transporter car MSC transporter	Loaded transportation cask or loaded MSC or WP
37. Subsurface Facilities: ***Drip Shield Installation***	Emplace drip shields with drip shield emplacement gantry similar to the WP emplacement operation Transport the drip shield emplacement gantry with a locomotive and gantry carrier to the emplacement drift turnout Drive the drip shield emplacement gantry into the drift using remote control operators and put the gantry on standby Transport drip shield to emplacement drift. After a drip shield carrier car docks at the emplacement drift, move the drip shield emplacement gantry over a drip shield by straddling the railcar. The gantry lifts the drip shield off the railcar then carries the shield through the emplacement drift and over the WPs to emplace the shield	Locomotive(s) Gantry carrier Drip shield emplacement gantry Drip shield Rail system and catenary system	WP(s)

Table III-1. Identification of Operations and Waste Form(s) at Risk (Continued)

Functional Areas [a]	**Synopsis of Waste-Related Operations** [a,c]	**Identified Relevant SSCs** [b]	**Expected Waste Form and Material at Risk**
38. ***Retrieval***	Included in emplacement evaluations	Included in emplacement evaluations	Included in emplacement evaluations
39. ***Site-Generated Radiological Waste Disposal***	None	N/A	Unspecified

NOTES: [a] Modified from BSC (2004p).

[b] Terms specified in BSC (2004p), Cogema (2004) and cites in Section 4.1.2.

[c] SNF Aging System modified from Cogema (2004).

[d] N/A = Not applicable, as no waste forms are handled in this operations area.

BWR = boiling water reactor; CHF = Canister Handling Facility; CSNF = commercial spent nuclear fuel; DPC = dual-purpose canister; DSNF = U.S. Department of Energy-owned spent nuclear fuel; DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; HAMs = horizontal aging modules; HLW = high-level radioactive waste; MCO = multi-canister overpack; MSC = monitored geologic repository site-specific cask; PWR = pressurized water reactor; SNF = spent nuclear fuel; SRTC = site rail transfer cart; WP = waste package.

Table III-2. Identification of Seismically Initiated Potential Events

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
1. ***Transportation Facility:*** 1. Railcar Staging Area 2. Truck Staging Area	***Drops, Slap Downs, Collisions:*** 1. Overturning of commercial transporter. 2. Collisions between transport vehicles. 3. Cask roll off from transport vehicles.	None identified
2. ***Receipt Systems:*** 1. Cask and Waste Package Receipt Building, containing: • Cask Receipt / Return Area of the Transportation Cask Receipt Return Facility (TCRRF) and • Warehouse & Non-Nuclear Receipt Facility (WNNRF), 2. Transportation Cask Buffer Area of the TCRRF	***Drops, Slap Downs, Collisions:*** 1. Overturning or collision of a site prime mover moving a legal-weight or overweight truck trailer holding a transportation cask (with impact limiters and personnel barrier installed). 2. Derailment, overturning, or collision involving a site prime mover moving an offsite railcar holding a transportation cask (with impact limiters and personnel barrier installed) followed by a load tipover or fall. 3. Collision involving a forklift and a cask on a railcar or a legal-weight or an overweight truck trailer (with or without impact limiters and personnel barrier installed). 4. Collision involving a mobile elevating platform and a cask on a railcar or a legal-weight or an overweight truck trailer (with or without impact limiters and personnel barrier installed). 5. Drop of a transportation cask and its support skid (with impact limiters and personnel barrier installed) from the cask receipt and return area overhead crane during transfer to an SRTC. 6. Drop or collision of a transportation cask and a support skid (with impact limiters and personnel barrier installed) from cask receipt and return area overhead crane onto or against a sharp object during transfer to an SRTC. 7. Drop of a transportation cask with impact limiters and personnel barrier removed (including the NSNF cask or a transportation cask carrying a horizontal DPC not going to the SNF Aging System) from the cask receipt and return area overhead crane during transfer to an SRTC. 8. Drop or collision of a transportation cask with impact limiters and personnel barrier removed (including the NSNF cask or a transportation cask carrying a horizontal DPC not going to the SNF Aging System) from the cask receipt and return area overhead crane onto or against a sharp object during transfer to an SRTC.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
2. ***Receipt Systems:*** (Continued)	***Drops, Slap Downs, Collisions:*** 9. Drop of a horizontal transportation cask containing a horizontal DPC (with impact limiters and personnel barrier removed) from the cask receipt and return area overhead crane during transfer to a horizontal cask transfer trailer (for subsequent emplacement in a HAM). 10. Drop or collision of a transportation cask containing a horizontal DPC (with impact limiters and personnel barrier removed) from the cask receipt and return area overhead crane onto or against a sharp object during transfer to a horizontal cask transfer trailer (for subsequent emplacement in a HAM). 11. Slap down of a naval transportation cask or a transportation cask carrying a horizontal DPC (or other cask requiring removal of impact limiters prior to transfer) from the cask receipt and return area overhead crane back onto the railcar (forward slap down) or the ground or site prime mover (backward slap down) during the upending of the cask to a vertical orientation from a horizontal orientation during cask removal from the offsite railcar or other transport. 12. Slap down of a naval transportation cask (or other cask requiring removal of impact limiters prior to transfer) from the cask receipt and return area overhead crane onto the SRTC (forward slap down) or the ground or SRTC tractor (backward slap down) during the down ending of the cask from a vertical to a horizontal orientation after cask removal from the offsite railcar or other transport. 13. Slap down of a horizontal transportation cask holding a horizontal DPC (with impact limiters removed) from the cask receipt and return area overhead crane onto the horizontal cask transfer trailer or the site prime mover (forward slap down) or the ground (backward slap down) during the down ending of the cask from a vertical to a horizontal orientation after cask removal from the offsite railcar or other transport. 14. Overturning or collision involving the site prime mover pulling a horizontal cask transfer trailer holding a transportation cask (without impact limiters) containing a horizontal DPC at the TCRRF or departing the TCRRF for a HAM. 15. Runaway of a site prime mover pulling a horizontal cask transfer trailer holding a transportation cask (with no impact limiters) containing a horizontal DPC. 16. Drop or collision of handling equipment onto or against a transportation cask (with impact limiters and personnel barrier installed). 17. Drop or collision of handling equipment onto or against a transportation cask (without impact limiters or personnel barrier installed).	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
2. ***Receipt Systems:*** (Continued)	***Drops, Slap Downs, Collisions:*** 18. Drop or collision of heavy loads from the maintenance crane onto or against a transportation cask (with or without impact limiters or personnel barrier installed). 19. Derailment of the SRTC positioner moving an SRTC holding a transportation cask (with impact limiters and personnel barrier installed) resulting in an SRTC collision or derailment followed by a load tipover or fall. 20. Derailment of the SRTC positioner moving an SRTC holding a transportation cask (with impact limiters and personnel barrier installed) due to a malfunction of the turntable in the TCBA, resulting in an SRTC collision or derailment followed by a load tipover or fall. 21. Roll-off and/or derailment of an SRTC holding a transportation cask (with impact limiters and personnel barrier installed) from the SRTC positioner followed by a load tipover or fall. 22. Collision of a SRTC tractor and an SRTC holding a transportation cask (with impact limiters and personnel barrier installed). 23. Derailment or collision involving an SRTC holding a transportation cask (with impact limiters and personnel barrier installed) being pushed or pulled by an SRTC tractor followed by a load tipover or fall. 24. SRTC carrying a transportation cask (with impact limiters installed) from the C&WPRB to the TCBA, the DTF, or the CHF is pushed by the SRTC tractor into the SRTC positioner trench. 25. Drop of a transfer cask containing a horizontal DPC (with impact limiters removed) from the cask receipt and return area overhead crane during transfer from a horizontal cask transfer trailer (after retrieval from a HAM) to an SRTC for processing in the DTF. 26. Drop or collision of a transfer cask containing a horizontal DPC (with impact limiters removed) from the cask receipt and return area overhead crane onto or against a sharp object during transfer from a horizontal cask transfer trailer (after retrieval from a HAM) to an SRTC for processing in the DTF. 27. Slap down of a transfer cask holding a horizontal DPC (without impact limiters) from the cask receipt and return area overhead crane back onto the horizontal cask transfer trailer or the site prime mover (forward slap down) or the ground (backward slap down) during the upending of the cask to a vertical orientation from a horizontal orientation during the transfer of the cask from the horizontal cask transfer trailer to an SRTC.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
*2. **Receipt Systems:*** (Continued)	***Drops, Slap Downs, Collisions:*** 28. Slap down of a transfer cask holding a horizontal DPC (without impact limiters) from the cask receipt and return area overhead crane onto an SRTC or SRTC Tractor (forward slap down) or the ground (backward slap down) during the down ending of the cask to a vertical orientation from a horizontal orientation after removal from the horizontal cask transfer trailer. 29. Overturning or collision involving the site prime mover pulling a horizontal cask transfer trailer holding a transfer cask (without impact limiters) containing a horizontal DPC in transit to, or at, the TCRRF. 30. Runaway of a site prime mover pulling a horizontal cask transfer trailer holding a transfer cask (with no impact limiters) containing a horizontal DPC. ***Fires:*** 1. Fire/explosion (battery/electrical fire) involving a site prime mover moving an LWT or OWT trailer holding a transportation cask. 2. Fire/explosion (battery/electrical fire) involving a site prime mover moving a railroad car holding a rail transportation cask. 3. Fire/explosion (battery/electrical fire) involving a site prime mover pulling or pushing a horizontal cask transfer trailer holding a horizontal transport cask containing a horizontal DPC (at the TCRRF or in transit to a HAM). 4. Fire/explosion (battery/electrical fire) involving a site prime mover pulling or pushing a horizontal cask transfer trailer holding a transfer cask containing a horizontal DPC (at the TCRRF or in transit from a HAM). 5. Diesel fuel fire/explosion involving an SRTC tractor pushing or pulling an SRTC holding a transportation cask. 6. Electrical fire associated with a mobile elevating platform (electrical/battery). 7. Electrical fire involving the cask receipt and return area overhead crane, handling equipment, or other electrical equipment. 8. Electrical fire involving the turntable carrying the SRTC positioner holding an SRTC loaded with a transportation cask. 9. Electrical fire associated with a forklift (electrical/battery). 10. Electrical fire associated with a mobile elevating platform (electrical/battery). 11. Transient combustible fire in C&WPRB or the TCBA.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
2. ***Receipt Systems:*** (Continued)	***Fires:*** 12. N/S [d] ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. N/S ***Criticality:*** 1. Criticality associated with a transportation cask collision, drop, or slap down (involving a crane) and a rearrangement of the cask internals. 2. Criticality associated with an offsite railcar collision or derailment (holding a transportation cask) followed by a load tipover or fall and a rearrangement of the cask internals. 3. Criticality associated with a collision or overturning of an LWT or OWT trailer (holding a transportation cask) and a rearrangement of the cask internals. 4. Criticality associated with an SRTC collision or derailment (holding a transportation cask) followed by a load tipover or fall and a rearrangement of the cask internals. 5. Criticality associated with an SRTC positioner collision or derailment (carrying an SRTC holding a transportation cask) followed by a load tipover or fall and rearrangement of the cask internals. 6. Criticality associated with a horizontal transport cask (holding a horizontal DPC) collision or derailment (involving a horizontal cask transfer trailer or railcar) followed by a load tipover or fall and a rearrangement of the cask internals. 7. Criticality associated with a horizontal transport cask (holding a horizontal DPC) drop or slap down from the cask receipt and return area overhead crane and a rearrangement of the cask internals. 8. Criticality associated with a transfer cask (holding a horizontal DPC) collision or derailment (involving a horizontal cask transfer trailer or an SRTC) followed by a load tipover or fall and a rearrangement of the cask internals. 9. Criticality associated with a transfer cask (holding a horizontal DPC) drop or slap down from the cask receipt and return area overhead crane and a rearrangement of the cask internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
3. CHF: ***Cask Receipt*** Entrance Vestibule, Tools/Parts Storage Room	***Drops, Slap Downs, Collisions:*** 1. SRTC derailment, overturning, or collision involving a loaded cask followed by a load tipover or fall. 2. Overturning or collision involving a legal-weight truck trailer or overweight truck trailer holding a cask. 3. SRTC derailment, overturning, or collision involving a loaded MSC followed by a load tipover or fall. 4. Collision of an SRTC, a legal-weight truck trailer, or overweight truck trailer carrying a loaded cask with the entrance vestibule doors, tool/parts storage room doors, or the canister transfer cell shield doors. 5. The entrance vestibule doors, tool/parts storage room doors, or the canister transfer cell shield doors close on an SRTC, a legal-weight truck trailer, or an overweight truck trailer carrying a loaded cask. 6. Collision of an SRTC carrying a loaded MSC with the entrance vestibule doors, tool/parts storage room doors, or the canister transfer cell shield doors. 7. The entrance vestibule doors, tool/parts storage room doors, or the canister transfer cell shield doors close on an SRTC carrying a loaded MSC. 8. Collision of a mobile elevating platform with a cask during removal of personnel barriers and impact limiters or during survey activities. 9. Drop or collision of personnel barriers or impact limiters from the entrance vestibule overhead crane onto or against a cask. 10. Collision between a forklift and a cask on an SRTC, a legal-weight truck trailer or overweight truck trailer or the conveyance holding the cask. 11. Collision between a mobile elevating platform and a cask on an SRTC, a legal-weight truck trailer or overweight truck trailer or the conveyance holding the cask. 12. Collision between a forklift and an MSC on an SRTC or the SRTC holding the cask. 13. Collision between a mobile elevating platform and an MSC on an SRTC or the SRTC holding the MSC. 14. Drop or collision of equipment from the entrance vestibule overhead bridge crane (including handling equipment for personnel barrier, impact limiters, etc.) onto or against a cask or MSC.	***Seismically-Unique:*** 1. Collapse of structures. 2. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
3. CHF: ***Cask Receipt*** Entrance Vestibule, Tools/Parts Storage Room (Continued)	***Fires:*** 1. Electrical fire associated with the entrance vestibule overhead crane. 2. Electrical fire associated with handling equipment or other entrance vestibule electrical equipment. 3. Diesel fuel fire/explosion involving a diesel-powered SRTC tractor pulling or pushing an SRTC holding a loaded cask or MSC. 4. Fire/explosion (battery/electrical fire) involving a site prime mover pulling or pushing a legal-weight or overweight truck trailer holding a loaded cask. 5. Electrical fire associated with a forklift (electrical/battery). 6. Electrical fire associated with a mobile elevating platform (electrical/battery). 7. Transient combustible fire in the entrance vestibule or the tools/parts storage room. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. N/S ***Criticality:*** 1. Criticality associated with an SRTC (holding a cask) derailment or collision followed by a load tipover or fall and rearrangement of the cask internals. 2. Criticality associated with overturning or collision involving an LWT or an OWT trailer holding a cask and rearrangement of cask internals. 3. Criticality associated with an SRTC (holding a loaded MSC) derailment or collision followed by a load tipover or fall and rearrangement of the cask internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
4. CHF: ***Canister Transfer*** Canister Transfer Cell	***Drops, Slap Downs, Collisions:*** 1. Slap down of a cask onto an SRTC, a truck trailer, or the floor during upending of the cask to the vertical orientation. 2. Drop of a cask from a canister transfer cell overhead crane onto the floor during the transfer from an SRTC or truck trailer to the cask preparation pit. 3. Drop or collision of a cask from a canister transfer cell overhead crane onto or against a sharp object during the transfer from an SRTC or truck trailer to the cask preparation pit. 4. Drop of a loaded MSC from a canister transfer cell overhead crane onto the floor during the transfer from an SRTC to the cask preparation pit. 5. Drop or collision of a loaded MSC from a canister transfer cell overhead crane onto or against a sharp object during the transfer from an SRTC to the cask preparation pit. 6. Drop or collision of a cask from a canister transfer cell overhead crane into or against the cask preparation pit or an MSC/WP loading pit during the transfer from an SRTC or truck trailer to the cask preparation pit. 7. Drop or collision of a loaded MSC from a canister transfer cell overhead crane into or against the cask preparation pit or an MSC/WP loading pit during the transfer from the SRTC to the cask preparation pit. 8. Slap down of a cask or MSC in the pit area due to off-center cask or MSC lowering into the cask preparation pit and followed by a cask or MSC corner drop onto the edge of the pit and slap down. 9. Drop or collision involving the pit moveable platform onto or against a cask or MSC in the cask preparation pit. 10. Handling equipment drop onto or against a cask or MSC. 11. Drop of a cask or MSC outer lid from a canister transfer cell overhead crane onto a cask or MSC inner lid, as applicable. 12. Drop of a cask or MSC inner lid from a canister transfer cell overhead crane onto a canister inside the cask or MSC, as applicable. 13. Drop or collision of tools or handling equipment (including the outer lid-lifting fixture, inner lid-lifting fixture, etc.) onto or against a cask or MSC outer lid or a cask or MSC inner lid, as applicable.	***Seismically-Unique:*** 1. Collapse of structure; 2. Failure of equipment supports; 3. Failure of shield walls, shield doors or view ports to protect against radiation; 4. Failure of airlock doors view ports for airborne confinement; 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	***Drops, Slap Downs, Collisions:*** 14. Drop or collision of tools or handling equipment, including a lift fixture with pintle or a shield ring, onto or against a canister inside an open cask or MSC. 15. Drop of a canister from a canister transfer cell overhead crane back into the cask or MSC being unloaded (including a NSNF canister, an MCO, a DPC, a DOE HLW canister, or a DOE SNF canister). 16. Drop or collision of a DOE HLW canister or a DOE SNF canister from a canister transfer cell overhead crane onto or against another DOE SNF canister, or DOE HLW canister in the cask being unloaded, as applicable. 17. Impact due to horizontal of a canister before it is fully vertically lifted out of a cask or MSC. 18. Drop of a canister from a canister transfer cell overhead crane onto the cell floor or other flat object during transfer from the cask or MSC to a WP or an MSC, as applicable, or during transfer to a canister staging pit. 19. Drop or collision of a canister from a canister transfer cell overhead crane onto or against a sharp object during transfer from the cask or MSC to a WP or an MSC, as applicable, or during transfer to a canister staging pit. 20. Slap down of a canister in an MSC/WP loading pit or the pit areas due to off-center canister lowering into the WP or MSC, followed by a canister corner drop onto the edge of the pit and slap down. 21. Drop or collision of a DPC, DOE HLW canister, or DOE SNF canister from a canister transfer cell overhead crane into or against the empty MSC being loaded. 22. Drop or collision of a NSNF canister, a DOE HLW canister, an MCO, or a DOE SNF canister from a canister transfer cell overhead crane into or against the WP being loaded. 23. Drop or collision of a DOE HLW canister from a canister transfer cell overhead crane onto or another DOE HLW canister, an MCO, or a DOE SNF canister in a WP. 24. Drop or collision of a DOE HLW canister from a canister transfer cell overhead crane onto or another DOE HLW canister or a DOE SNF canister in an MSC. 25. Drop or collision of a DOE SNF canister from a canister transfer cell overhead crane onto or against a DOE HLW canister in a WP or MSC. 26. Drop or collision of an MCO from a canister transfer cell overhead crane onto or against another MCO or onto a DOE HLW canister in a WP.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	***Drops, Slap Downs, Collisions:*** 27. Drop or collision of an MCO from a canister transfer cell overhead crane onto or against a DOE SNF canister or a drop of a DOE SNF canister onto or against another DOE SNF canister in a WP due to a misload. 28. Drop or collision of an MCO from a canister transfer cell overhead crane onto or against a DOE SNF canister or onto or against a DOE HLW canister in an MSC due to a misload. 29. Drop or collision of a DOE HLW canister or a DOE SNF canister from a canister transfer cell overhead crane into or against a canister staging pit. 30. Slap down of a DOE HLW canister or a DOE SNF canister in the staging pit area due to off-center canister lowering into the pit and followed by a canister corner drop onto the edge of the staging pit and a slap down. 31. Drop or collision of a DOE HLW canister or a DOE SNF canister from a canister transfer cell overhead crane onto or against the top of another DOE HLW canister or DOE SNF canister in a canister staging pit. 32. Impact due to horizontal movement of a canister before it is fully vertically lifted out of a canister staging pit. 33. Drop of or collision of handling equipment onto or against a DOE HLW canister or a DOE SNF canister in a canister staging pit. 34. Drop of or collision of a canister staging pit shield plug onto or against a canister in the canister staging pit. 35. Drop or collision involving the pit moveable platform onto or against a loaded MSC in an MSC/WP loading pit. 36. Drop of a WP inner lid into an open, loaded WP. 37. Drop of the MSC lid into an open, loaded MSC. 38. Drop or collision of tools or handling equipment into or against an open, loaded or partially loaded WP. 39. Drop or collision of tools or handling equipment into or against an open, loaded or partially loaded MSC. 40. Drop or collision of tools or equipment (including a lid-lifting fixture) onto or against a loaded WP inner lid. 41. Drop or collision of tools or equipment (including a lid-lifting fixture) onto or against the lid of a loaded, unsealed or sealed MSC.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	***Fires:*** 1. Electrical fire associated with the canister transfer cell overhead cranes. 2. Electrical fire associated with handling equipment or other canister transfer cell electrical equipment. 3. Diesel fuel fire/explosion on an SRTC tractor pushing an SRTC holding a loaded cask into the transfer area. 4. Fire/explosion (battery/electrical fire) involving a site prime mover pulling or pushing a legal-weight or overweight truck trailer holding a loaded cask. 5. Diesel fuel fire/explosion associated with the SRTC tractor pushing an SRTC holding an MSC. 6. Electrical fire associated with a forklift (electrical/battery). 7. High-efficiency particulate air (HEPA) filter fire due to excessive radioactive decay within the filter bed. 8. Canister overheating in the canister staging pit due to a loss of cooling resulting in excessive temperature and possible damage to canister contents and/or confinement. 9. Transient combustible fire in the canister transfer cell. 10. Overheating of a loaded cask, WP, or MSC while staged in a pit due to a loss of cooling resulting in excessive temperature and possible damage to canister contents. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Damage or rupture of cask sampling and purging system, leading to a release of cask internal gasses and radioactive material. 4. N/S 5. Inadvertent opening of a canister transfer cell shield door, leading to a worker exposure. 6. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
4. CHF: ***Canister Transfer*** Canister Transfer Cell (Continued)	***Criticality:*** 1. Criticality associated with a drop or slap down of a loaded cask from a canister transfer cell overhead crane and a rearrangement of cask internals. 2. Criticality associated with a drop or slap down of a loaded MSC from a canister transfer cell overhead crane and a rearrangement of cask internals. 3. Criticality associated with a drop or slap down of a loaded WP (unsealed) from a canister transfer cell overhead crane and a rearrangement of WP internals. 4. Criticality associated with a drop or slap down of a DOE SNF canister, a NSNF canister, an MCO, a DPC, or a DOE HLW canister and a rearrangement of canister internals. 5. N/S 6. N/S 7. Criticality associated with a drop of heavy equipment onto an unsealed, loaded cask, WP, or MSC and a rearrangement of the container internals.	See prior page.
5. CHF: ***WP Transfer to WP Closure, MSC Closure and Removal*****,** ***Canister Transfer Cell***	Drops, Slap Downs, Collisions: 1. Drop or collision of handling equipment or a lifting fixture onto or against a loaded WP inner lid. 2. Drop or collision of handling equipment or a lifting fixture onto or against a loaded MSC lid. 3. Impact due to horizontal movement of a loaded WP by a canister transfer cell overhead crane before it is fully lifted vertically out of the MSC/WP loading pit. 4. Drop or collision of an unsealed, loaded WP from a canister transfer cell overhead crane back into or against the MSC/WP loading pit. 5. Drop of an unsealed, loaded WP from a canister transfer cell overhead crane onto the cell floor or a pit cover during the lift and transfer to the WP positioning cell pedestal and trolley. 6. Drop or collision of an unsealed, loaded WP from a canister transfer cell overhead crane onto or against a sharp object during the lift and transfer to the WP positioning cell pedestal and trolley. 7. Slap down of a loaded, unsealed WP onto the cell floor, into a wall, or onto a pit cover following a drop from a canister transfer cell overhead crane onto the edge of the trolley, a pit edge, or pit cover during the lift and transfer to the WP positioning cell pedestal and trolley.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, shield doors or view ports to protect against radiation. 4. Failure of airlock doors view ports for airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
5. CHF: ***WP Transfer to WP Closure, MSC Closure and Removal*, *Canister Transfer Cell*** (Continued)	8. Drop or collision of an unsealed, loaded WP from a canister transfer cell overhead crane onto or against a loaded or partially loaded MSC or WP (with no lid in place) in an MSC/WP loading pit (with no pit cover in place) during the lift and transfer to the WP positioning cell pedestal and trolley. 9. Drop or collision of a unsealed, loaded WP from a canister transfer cell overhead crane onto or against a loaded MSC or WP (with lid in place) in an MSC/WP loading pit (with no pit cover in place) during the lift and transfer to the WP positioning cell pedestal and trolley. 10. Drop or collision of an unsealed, loaded WP from a canister transfer cell overhead crane or against a loaded, unsealed WP on the opposite WP positioning cell pedestal and trolley during the lift and transfer to a WP positioning cell pedestal and trolley. 11. Drop or collision of an unsealed, loaded WP from a canister transfer cell overhead crane onto or against a loaded, sealed WP on the opposite WP positioning cell pedestal and trolley during the lift and transfer to a WP positioning cell pedestal and trolley. 12. Slap down of a loaded, unsealed WP onto the floor and then across or into an empty MSC/WP loading pit (with no pit cover in place) following a drop from a canister transfer cell overhead crane onto the edge of the trolley or pit edge during the lift and transfer to the WP positioning cell pedestal and trolley. 13. Slap down of a loaded, unsealed WP onto the floor and then across or into an MSC/WP loading pit (with no pit cover in place and a loaded or partially loaded, sealed or unsealed MSC or WP in place) following a drop from a canister transfer cell overhead crane onto the edge of the trolley or pit edge during the lift and transfer to the WP positioning cell pedestal and trolley. 14. Slap down of a loaded, unsealed WP that subsequently impacts a loaded, unsealed WP on the opposite WP positioning cell trolley following a drop from a canister transfer cell overhead crane onto the edge of the opposite WP positioning cell trolley, a pit edge, or other object during the lift and transfer to the WP positioning cell pedestal and trolley. 15. Slap down of a loaded, unsealed WP that subsequently impacts a loaded, sealed WP on the opposite WP positioning cell trolley following a drop from a canister transfer cell overhead crane onto the edge of the WP positioning cell trolley, a pit edge, or other object during the lift and transfer to the WP positioning cell pedestal and trolley.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
5. CHF: ***WP Transfer to WP Closure, MSC Closure and Removal, Canister Transfer Cell*** (Continued)	***Drops, Slap Downs, Collisions:*** 16. Impact due to horizontal movement of an MSC by a canister transfer cell overhead crane before it is fully vertically lifted out of the MSC/WP loading pit. 17. Drop or collision of a loaded, sealed MSC from a canister transfer cell overhead crane back into or against the MSC/WP loading pit during MSC removal and transfer to the SRTC. 18. Slap down of a loaded, sealed MSC onto the cell floor, into a wall, or onto a pit cover following a drop from a canister transfer cell overhead crane onto the edge of the MSC/WP loading pit or the SRTC during MSC removal from the pit and transfer to the SRTC. 19. Drop or collision of a loaded, sealed MSC from a canister transfer cell overhead crane onto or against the SRTC following removal of the MSC from the MSC/WP loading pit during transfer to the SRTC for removal from the building. 20. Drop of a loaded, sealed MSC from a canister transfer cell overhead crane onto the canister transfer cell floor or a pit cover following removal of the MSC from the MSC/WP loading pit. 21. Drop or collision of a loaded, sealed MSC from a canister transfer cell overhead crane onto or against a sharp object following removal of the MSC from the MSC/WP loading pit. 22. Collision of the SRTC (holding a loaded, sealed MSC) with the entrance vestibule doors, the tool/parts storage room doors, or the canister transfer cell shield doors. 23. The entrance vestibule doors, the tool/parts storage room doors, or the canister transfer cell shield doors close on the SRTC holding a loaded, sealed MSC. ***Fire:*** 1. Electrical fire associated with the canister transfer cell overhead cranes. 2. Electrical fire associated with handling equipment or other canister transfer cell electrical equipment. 3. Diesel fuel fire/explosion associated with the SRTC tractor pulling an SRTC holding an MSC. 4. N/S [d] 5. Transient combustible fire in the canister transfer cell. 6. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
5. CHF: ***WP Transfer to WP Closure, MSC Closure and Removal, Canister Transfer Cell*** (Continued)	***Fire:*** 7. Overheating of a loaded, unsealed (and uninerted) WP or MSC due to a loss of cooling resulting in excessive temperature and possible damage to canister contents. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Inadvertent opening of a canister transfer cell shield door or a WP positioning cell shield door, leading to a worker exposure. 4. N/S ***Criticality:*** 1. Criticality associated with a drop or slap down of a loaded MSC from a canister transfer cell overhead crane and a rearrangement of cask internals. 2. Criticality associated with an SRTC (holding a loaded MSC) derailment or collision followed by a load tipover or fall and rearrangement of the cask internals. 3. Criticality associated with a drop or slap down of a loaded, unsealed WP from a canister transfer cell overhead crane and a rearrangement of WP internals. 4. Criticality associated with a drop of heavy equipment onto an unsealed, loaded WP or MSC and a rearrangement of the container internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
6. CHF: ***WP Closure***	***Drops, Slap Downs, Collision:*** 1. Derailment of a trolley holding a loaded, unsealed WP followed by a load tipover or fall. 2. Drop or collision of equipment from a canister transfer cell overhead crane onto or against a loaded, unsealed WP positioned on a pedestal on a trolley. 3. Collision involving the trolley holding the loaded, unsealed WP and the shield doors between the canister transfer cell and the WP positioning cell. 4. Shield doors between the canister transfer cell and the WP positioning cell close on the trolley holding the loaded, unsealed WP. 5. Lid drop onto a WP from the lid placement fixture equipment during the welding process. 6. Equipment drop onto a WP during the welding process. 7. Drop or collision of equipment from a canister transfer cell overhead crane onto or against a loaded, sealed WP positioned on a pedestal on a trolley. 8. Collision involving the trolley holding the loaded, sealed WP and the shield doors between the WP positioning cell and the canister transfer cell. 9. Shield doors between the WP positioning cell and the canister transfer cell close on the trolley holding the loaded, sealed WP. ***Fire:*** 1. Electrical fire associated with HLW handling equipment and other electrically powered equipment in the WP closure cell or the WP positioning cell, including the overhead cranes and the welders in the WP closure cells. 2. Electrical fire associated with a motor on a WP trolley. 3. N/S 4. N/S 5. Overheating of a loaded WP due to a loss of cooling resulting in excessive temperature and possible damage to the canister contents. 6. Transient combustible fire in the WP closure cell or the WP positioning cell. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, shield doors, glove box or view ports to protect against radiation. 4. Failure of airlock doors for airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
6. CHF: ***WP Closure*** (Continued)	***Radiation:*** 2. Glovebox leak leads to a radiological release. 3. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 4. Inadvertent opening of a canister transfer cell shield door or a WP positioning cell shield door, leading to a worker exposure. 5. N/S ***Criticality:*** 1. Criticality associated with a trolley holding a sealed or unsealed WP derailment followed by a load tipover or fall and rearrangement of the container internals. 2 Criticality associated with a drop of heavy equipment onto an unsealed, loaded WP and a rearrangement of the container internals.	See prior page.
7. CHF: ***WP Loadout*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule	***Drops, Slap Downs, Collision:*** 1. Derailment of a trolley holding a loaded, sealed WP followed by a load tipover or fall. 2. Drop of a loaded, sealed WP from a canister transfer cell overhead crane onto the floor during transfer from the trolley to the survey area. 3. Drop or collision of a loaded, sealed WP from a canister transfer cell overhead crane onto or against a sharp object during transfer from the trolley to the survey area. 4. Slap down of a loaded, sealed WP that subsequently impacts a loaded, unsealed WP on the opposite WP positioning cell trolley following a drop from a canister transfer cell overhead crane onto the edge of the opposite WP positioning cell trolley, a pit edge, or other object during the lift and transfer to the survey area. 5. Slap down of a loaded, sealed WP that subsequently impacts a loaded, sealed WP on the opposite WP positioning cell trolley following a drop from a canister transfer cell overhead crane onto the edge of the WP positioning cell trolley, a pit edge, or other object during the lift and transfer to the survey area. 6. Drop or collision of a sealed, loaded WP from a canister transfer cell overhead crane onto or against a loaded, unsealed WP on the opposite WP positioning cell pedestal and trolley during the lift and transfer to the survey area.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, or shield doors to protect against radiation. 4. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
7. CHF: ***WP Loadout*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule (Continued)	***Drops, Slap Downs, Collision:*** 7. Drop or collision of a sealed, loaded WP from a canister transfer cell overhead crane onto or against a loaded, sealed WP on the opposite WP positioning cell pedestal and trolley during the lift and transfer to the survey area. 8. Drop of a loaded, sealed WP from a canister transfer cell overhead crane onto the floor during the transfer from the survey area to the tilting machine. 9. Drop of a loaded, sealed WP from a canister transfer cell overhead crane back onto the pedestal on the trolley during the transfer from the survey area to the tilting machine. 10. Drop or collision of a loaded, sealed WP from a canister transfer cell overhead crane onto or against a sharp object (including the tilting machine) during transfer from the survey area to the tilting machine. 11. Slap down (either forward into the WP turntable or backward onto the floor) of a loaded, sealed WP in the tilting machine from a canister transfer cell overhead crane during the lowering of the WP to the horizontal position on the emplacement pallet previously placed on the WP turntable. 12. Collision of the tilting machine against a loaded, sealed WP on an emplacement pallet on the WP turntable. 13. Drop or collision of a lifting collar from a canister transfer cell overhead crane onto or against a WP after removal of the collar from the WP collar removal machine. 14. Collision or impact of the trunion collar removal machine and a loaded, sealed WP positioned on an emplacement pallet positioned on the WP turntable. 15. Drop of a loaded, sealed WP positioned on a emplacement pallet (from a horizontal position) from a canister transfer cell overhead crane onto the floor or the bedplate during transfer of the WP and emplacement pallet from the WP turntable to the WP transporter bedplate. 16. Drop or collision of a loaded, sealed WP positioned on a emplacement pallet (from a horizontal position) from a canister transfer cell overhead crane onto or against a sharp object during transfer of the WP and emplacement pallet from the WP turntable to the WP transporter bedplate. 17. Equipment drop or collision (including lifting yokes) onto or against a loaded, sealed WP when the WP is on the emplacement pallet on the WP turntable or when the WP is on the emplacement pallet on the WP transporter bedplate.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
7. CHF: ***WP Loadout*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 18. Collision involving a WP transporter (holding the sealed WP on an emplacement pallet) and the shield doors between the canister transfer cell and the WP tool storage room. 19. The shield doors between the canister transfer cell and the WP tool storage room close on the WP transporter (holding the sealed WP on an emplacement pallet). 20. Collision involving WP transporter (holding the sealed WP on an emplacement pallet) and the doors between the WP tool storage room and the exit vestibule. 21. The doors between the WP tool storage room and the exit vestibule close on the WP transporter (holding the sealed WP on an emplacement pallet). 22. Collision involving WP transporter (holding the sealed WP on an emplacement pallet) and the doors between the exit vestibule and the ambient air (outside). 23. Doors between the exit vestibule and the ambient air (outside) close on the WP transporter (holding the sealed WP on an emplacement pallet). 24. Derailment of a WP transporter in the exit vestibule, WP tool storage room, or WP loadout area of the canister transfer cell followed by a load tipover or fall. ***Fire:*** 1. Electrical fire associated with the WP transporter loadout area housing the equipment for WP tilt and WP transporter loading, as well as the WP tool storage room and the exit vestibule (including the WP collar removal machine, the tilting machine, and the WP rotating turntable). 2. Electrical fire associated with the WP transporter loadout area overhead bridge cranes. 3. Electrical fire associated with equipment on the WP transporter, including motors to extend the WP transporter bedplate. 4. Electrical fire associated with the WP transporter locomotive. 5. Electrical fire associated with a motor on a WP trolley. 6. Overheating of a loaded, sealed WP due to a loss of cooling resulting in excessive temperature and possible damage to the canister contents. 7. Transient combustible fire in the WP transporter load area, canister transfer area, the WP transporter vestibule tool storage room, or the exit vestibule.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
7. CHF: ***WP Loadout*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule (Continued)	***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Inadvertent opening of a canister transfer cell shield door, leading to a worker exposure. 4. Inadvertent opening of the WP transporter shielded enclosure doors, leading to a worker exposure. ***Criticality:*** 1. Criticality associated with a trolley holding a WP derailment followed by a load tipover or fall and rearrangement of the WP internals. 2. Criticality associated with a drop, slap down, or collision of a WP and a rearrangement of the container internals. 3. Criticality associated with a slap down of a WP and a rearrangement of the container internals.	See prior page.
8. CHF: ***Empty Transportation Cask and MSC Removal*** Canister Transfer Cell, WP Tool Storage Room, Exit Vestibule	None identified.	***Seismically-Unique:*** None identified.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
9. DTF: ***Cask & MSC Receipt*** Cask and MSC Entrance Vestibule, Cask and MSC SRTC Receipt Area, Cask and MSC to Trolley Transfer Room	***Drops, Slap Downs, Collisions:*** 1. SRTC derailment involving a loaded cask (with impact limiters installed) followed by a load tipover or fall. 2. Collision of an SRTC carrying a loaded cask (with impact limiters installed) with the cask and MSC entrance vestibule doors or the cask and MSC SRTC receipt area doors. 3. The cask and MSC entrance vestibule doors or the cask and MSC SRTC receipt area doors close on an SRTC carrying a loaded cask (with impact limiters installed). 4. MSC transporter collision or overturning involving a loaded MSC followed by a load tipover or fall. 5. Collision of an MSC transporter carrying a loaded MSC with the cask and MSC entrance vestibule doors or the cask and MSC SRTC receipt area shield doors. 6. The cask and MSC entrance vestibule doors or the cask and MSC SRTC receipt area shield doors close on an MSC transporter carrying a loaded MSC. 7. Collision of a mobile elevating platform with a loaded cask during removal of the personnel barriers and impact limiters or during survey activities. 8. Forklift collision with a cask on an SRTC (with or without impact limiters installed on the cask) or the SRTC holding the cask. 9. Collision between a forklift and an MSC positioned on the floor, an MSC on a pedestal on a trolley, or the MSC transporter holding the MSC. 10. Collision between a mobile elevating platform and an MSC positioned on the floor, an MSC on a pedestal on a trolley, or the MSC transporter holding the MSC. 11. Drop or collision of personnel barriers or impact limiters from the receipt area crane onto or against a loaded cask. 12. Slap down of a loaded cask onto an SRTC during the upending of the loaded cask to the vertical orientation. 13. Drop of a loaded cask from an overhead crane onto the floor during the transfer from an SRTC to a pedestal already staged on a trolley. 14. Drop of a loaded cask from an overhead crane onto the pedestal on a trolley during the transfer from an SRTC to a pedestal already staged on a trolley. 15. Drop or collision of a loaded cask from an overhead crane onto or against a sharp object during the transfer from an SRTC to a pedestal previously positioned on a trolley.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, or shield doors to protect against radiation. 4. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
9. DTF: ***Cask & MSC Receipt*** Cask and MSC Entrance Vestibule, Cask and MSC SRTC Receipt Area, Cask and MSC to Trolley Transfer Room (Continued)	***Drops, Slap Downs, Collisions:*** 16. Slap down of a loaded cask following a drop from an overhead crane onto the edge of the trolley or pedestal during transfer of the cask from the SRTC to the pedestal. 17. Collision of a loaded cask suspended from an overhead crane with the shield doors separating the cask and MSC SRTC receipt area and the cask and MSC to trolley transfer room during the transfer of the cask from the SRTC to the trolley. 18. Closing of the shield doors separating the cask and MSC SRTC receipt area and the cask and MSC to trolley transfer room (striking a loaded cask while it is suspended from the overhead crane) during the transfer of the cask from the SRTC to the pedestal on a trolley. 19. Drop of a loaded MSC from an overhead crane onto the floor during the transfer from an SRTC to a pedestal previously positioned on a trolley. 20. Drop of a loaded MSC from an overhead crane onto the pedestal on a trolley during the transfer from an SRTC to a pedestal previously positioned on a trolley. 21. Drop or collision of a loaded MSC from an overhead crane onto or against a sharp object during the transfer from the floor (after delivery by the MSC transporter) to a pedestal already staged on trolley. 22. Collision of a loaded MSC suspended from an overhead crane with the shield doors separating the cask and MSC SRTC receipt area and the cask and MSC to trolley transfer room during transfer of the MSC from the floor (after delivery by the MSC transporter) to the pedestal on a trolley. 23. Closing of the shield doors separating the cask and MSC SRTC receipt area and the cask and MSC to trolley transfer room (striking a loaded MSC while it is suspended from the overhead crane) during the transfer of the MSC from the floor (after delivery by the MSC transporter) to the pedestal on a trolley. 24. Slap down of a loaded MSC following a drop from an overhead crane onto the edge of the trolley or pedestal during transfer of the MSC from the floor (after delivery by the MSC transporter) to the pedestal on a trolley. 25. Drop or collision of handling equipment from an overhead bridge crane onto or against a loaded cask or MSC. 26. Drop or collision of equipment from the maintenance crane onto or against a loaded cask or MSC.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
9. DTF: ***Cask & MSC Receipt*** Cask and MSC Entrance Vestibule, Cask and MSC SRTC Receipt Area, Cask and MSC to Trolley Transfer Room (Continued)	***Drops, Slap Downs, Collisions:*** 27. Collision of a trolley holding a cask or MSC on a pedestal with the shield doors separating the cask and MSC to trolley transfer room and the cask and MSC turntable room. 28. The shield doors separating the cask and MSC to trolley transfer room and the cask and MSC turntable room close on a trolley holding a loaded cask or MSC on a pedestal. 29. Derailment of a trolley holding a cask or MSC on a pedestal followed by a load tipover or fall. ***Fires:*** 1. Electrical fire associated with the cask and MSC SRTC receipt area overhead cranes. 2. Electrical fire associated with handling equipment or other electrical equipment in the cask and MSC entrance vestibule, cask and MSC SRTC receipt area, or the cask and MSC to trolley transfer room. 3. Diesel fuel fire/explosion involving an SRTC tractor pulling or pushing an SRTC holding a loaded cask. 4. Diesel fuel fire/explosion involving an MSC transporter holding a loaded MSC. 5. Fire/explosion (battery/electrical fire) associated with the cask trolley. 6. Fire/explosion (battery/electrical fire) associated with a forklift. 7. Fire/explosion (battery/electrical fire) associated with a mobile elevating platform. 8. Transient combustible fire in the cask and MSC SRTC receipt area, the cask and MSC entrance vestibule, or the cask and MSC to trolley transfer room. 9. N/S ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. ***Criticality:*** 1. Criticality associated with an SRTC derailment or collision followed by a load tipover or fall and a rearrangement of cask internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
9. DTF: ***Cask & MSC Receipt*** (Continued)	***Criticality:*** 2. Criticality associated with cask drop or collision and rearrangement of cask internals. 3. Criticality associated with an MSC drop or collision and rearrangement of cask internals. 4. Criticality associated with an SRTC (holding a loaded MSC) derailment or collision followed by a load tipover or fall and rearrangement of the cask internals	See prior page.
10. DTF: ***Preparation*** Cask/MSC Turntable Room, Cask Preparation Room	***Drops, Slap Downs, Collisions:*** 1. Derailment of a trolley holding a cask or MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable) followed by a load tipover or fall. 2. Derailment of a trolley holding a cask or MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable) due to a turntable malfunction followed by a load tipover or fall. 3. Collision of a trolley holding a cask or MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable) with shield doors separating the Cask/MSC turntable room and the cask preparation room. 4. Closure of the shield doors separating the cask/MSC turntable room and the cask preparation room onto the trolley holding a cask or MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable). 5. Collision involving two trolleys with at least one holding a cask or MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable). 6. Drop or collision of tools or equipment (including a lid-lifting fixture, lid bolts, etc.) onto or against a cask or MSC outer lid (if applicable) or a cask or MSC inner lid in the cask preparation room. 7. Drop of a cask or MSC outer lid from the overhead crane onto the cask or MSC (if applicable) in the cask preparation room. 8. Drop or collision of a docking ring onto or against a cask or MSC in the cask preparation room. ***Fires:*** 1. Electrical fire associated with the cask preparation area 20 ton overhead crane 2. Electrical fire associated with handling equipment or other cask preparation area equipment, including the turntable.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls or shield doors to protect against radiation. 4. Failure of airlock doors for airborne confinement.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
10. DTF: ***Preparation*** Cask/MSC Turntable Room, Cask Preparation Room	***Fires:*** 3. Fire/explosion (battery/electrical fire) associated with the trolley. 4. Transient combustible fire in the cask preparation room or the cask/MSC turntable room. 5. N/S 6. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of cask sampling and purging system, leading to a release of cask internal gases and radioactive material. 3. Thermal expansion of gases or other loss of confinement in an unsealed cask or MSC, leading to radiological release. 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 5. N/S ***Criticality:*** 1. Criticality associated with a cask or MSC collision followed by a load tipover or fall and a rearrangement of the cask internals. 2. Criticality associated with a cask or MSC trolley derailment followed by a load tipover or fall and a rearrangement of the cask internals.	See prior page.
11. DTF: ***Cask/MSC Docking*** Cask and MSC Docking Room	***Drops, Slap Downs, Collisions:*** 1. Derailment of a trolley holding a cask or MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) followed by a load tipover or fall. 2. Derailment of a trolley holding a cask or MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) due to a turntable malfunction followed by a load tipover or fall. 3. Collision of a trolley holding a cask or MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) with shield doors separating the cask preparation room and the cask/MSC turntable room or the shield doors separating the cask/MSC turntable room and the cask and MSC docking room.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls or shield doors to protect against radiation. 4. Failure of airlock doors for airborne confinement.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
11. DTF: ***Cask and MSC Docking*** Cask and MSC Docking Room (Continued)	***Drops, Slap Downs, Collisions:*** 4. Closure of the shield doors separating the cask preparation room and the cask/MSC turntable room or the shield doors separating the cask/MSC turntable room and the cask and MSC docking room onto the trolley holding a cask or MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place). 5. Collision involving two trolleys with at least one holding a cask or MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place). 6. Drop or collision of a docking port (mobile slab) onto or against a cask or MSC. 7. Drop or collision of a docking port plug onto or against a cask lid or MSC lid (with outer lid removed [if applicable] and inner lid unbolted but in place). 8. Drop of an inner lid into a cask or MSC (with outer lid removed [if applicable]). ***Fire:*** 1. Electrical fire associated with handling equipment or other cask and MSC docking room equipment (including the turntable). 2. Fire/explosion (battery/electrical fire) associated with the cask trolley. 3. Transient combustible fire in the cask preparation area, cask/MSC turntable room, and cask and MSC docking room. 4. N/S 5. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
11. DTF: ***Cask and MSC Docking*** Cask and MSC Docking Room (Continued)	***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Docking ring failure leads to a radiological release. 3. N/S 4. Thermal expansion of gases or other loss of confinement in an unsealed cask or MSC, leading to radiological release. 5. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 6. N/S ***Criticality:*** 1. Criticality associated with cask or MSC collisions or a trolley derailment followed by a load tipover or fall and a rearrangement of cask or MSC internals.	See prior page.
12. DTF: ***Empty WP and MSC Processing Prior to Loading***	None identified.	***Seismically-Unique:*** None identified.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
13. DTF: ***NSNF Receipt*** WP and Navy Cask Entrance Vestibule, WP/Navy Cask SRTC Receipt Area, WP/Navy to Trolley Transfer Room, WP/Navy Cask Preparation Room	***Drops, Slap Downs, Collisions:*** 1. SRTC derailment involving a loaded NSNF cask followed by a load tipover or fall. 2. Collision of an SRTC carrying a loaded NSNF cask with the WP and navy cask entrance vestibule doors or the WP/navy cask SRTC receipt area shield doors. 3. The WP and navy cask entrance vestibule doors or the WP/navy cask SRTC receipt area shield doors close on an SRTC carrying a loaded cask. 4. Collision of mobile elevating platforms with a loaded NSNF cask during removal of personnel barriers and impact limiters or during survey activities. 5. Forklift collision with a NSNF cask on an SRTC (with or without impact limiters installed on the cask) or the SRTC holding the cask. 6. Drop or collision of personnel barriers or impact limiters from the receipt area crane onto or against a loaded NSNF cask. 7. Slap down of a loaded NSNF cask onto an SRTC during upending of the loaded cask to the vertical orientation. 8. Drop of a loaded NSNF cask from the overhead crane onto the floor during the transfer from an SRTC to a pedestal previously positioned on a trolley. 9. Drop of a loaded NSNF cask from the overhead crane onto a pedestal on a trolley during the transfer from an SRTC to a pedestal previously positioned on a trolley. 10. Drop or collision of a loaded cask from the overhead crane onto or against a sharp object during the transfer from an SRTC to a pedestal previously positioned on trolley. 11. Collision of a loaded NSNF cask suspended from the overhead crane with the shield doors separating the WP/navy cask SRTC receipt area and the WP/navy to trolley transfer room during transfer of the NSNF cask from the SRTC to the trolley. 12. Closing of the shield doors separating the WP/navy cask SRTC receipt area and the WP/navy to trolley transfer room (striking the cask while the loaded cask is suspended from the overhead crane) during the transfer of the cask from the SRTC to the trolley.	

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
13. DTF: ***NSNF Receipt*** WP and Navy Cask Entrance Vestibule, WP/Navy Cask SRTC Receipt Area, WP/Navy to Trolley Transfer Room, WP/Navy Cask Preparation Room	***Drops, Slap Downs, Collisions:*** 13. Slap down of a loaded NSNF cask following a drop from the overhead crane onto the edge of the trolley or pedestal during transfer of the cask from the SRTC to the trolley. 14. Drop or collision of handling equipment from the overhead bridge crane onto or against a loaded NSNF cask. 15. Drop or collision of equipment from the overhead bridge crane onto or against a loaded NSNF cask. 16. Collision of a trolley holding a NSNF cask on a pedestal with shield doors separating the WP/navy to trolley transfer room and the WP/navy cask preparation room. 17. Closing of the shield doors separating the WP/navy to trolley transfer room and the WP/navy cask preparation room on a trolley holding a NSNF cask on a pedestal. 18. Derailment of a trolley holding a NSNF cask on a pedestal followed by a load tipover or fall. ***Fires:*** 1. Electrical fire associated with the WP/navy cask SRTC receipt area overhead cranes. 2. Electrical fire associated with handling equipment or other electrical equipment in the WP/navy cask SRTC receipt area, WP and navy cask entrance vestibule, the WP/navy to trolley transfer room, or the WP/navy cask preparation room. 3. Diesel fuel fire/explosion involving an SRTC tractor pulling or pushing an SRTC holding a loaded cask or canister. 4. Electrical fire associated with a trolley holding a NSNF cask containing a NSNF canister. 5. Fire/explosion (battery/electrical fire) associated with a forklift. 6. Fire/explosion (battery/electrical fire) associated with a mobile elevating platform. 7. Transient combustible fire in the WP and navy cask entrance vestibule, the WP/navy cask SRTC receipt area, the WP/navy cask to trolley transfer room , or the WP/navy cask preparation room. 8. N/S	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
13. DTF: ***NSNF Receipt*** WP and Navy Cask Entrance Vestibule, WP/Navy Cask SRTC Receipt Area, WP/Navy to Trolley Transfer Room, WP/Navy Cask Preparation Room	***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. N/S. ***Criticality:*** 1. Criticality associated with an SRTC derailment or collision followed by a load tipover or fall and a rearrangement of the NSNF cask internals. 2. Criticality associated with a NSNF cask drop, slap down, or collision and rearrangement of cask internals. 3. Criticality associated with NSNF cask trolley derailment followed by a load tipover or fall and a rearrangement of the cask internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
14. DTF: ***NSNF Processing*** WP Docking Cell, WP Loading (Naval Canister)/Docking Ring Removal Cell, WP Loading/Docking Ring Removal Cell	***Drops, Slap Downs, Collisions:*** 1. Derailment of a trolley holding a loaded NSNF cask on a pedestal followed by a load tipover or fall. 2. Drop or collision of handling equipment (such as the lid grapple) onto or against a NSNF cask outer lid (if applicable) or inner lid. 3. Drop of a NSNF cask inner lid (if applicable) from the WP docking cell crane onto a NSNF canister. 4. Drop or collision of handling equipment (such as a canister grapple) into or against an open NSNF cask loaded with a NSNF canister. 5. Drop or collision of a NSNF canister from the WP docking cell crane back into or against the NSNF cask being unloaded. 6. Fall of a NSNF canister from the WP docking crane onto the edge of the cask, the edge of the WP, or the edge of the transfer floor, followed by a slap down of the canister. 7. Drop or collision of a NSNF canister from the WP docking cell crane onto or against a sharp object. 8. Collision involving a NSNF canister suspended from the WP docking cell crane with equipment located in the WP docking cell or the WP loading (navy canister)/docking ring removal cell, such as lid lifting equipment. 9. Drop of a NSNF canister from the WP docking room crane onto the transfer cell floor. 10. Impact due to horizontal movement of the NSNF canister before it is completely removed from the naval transportation cask. 11. Drop or collision of a NSNF canister from the 70 ton navy canister handling crane into or against the WP. 12. Drop or collision of handling equipment into or against an open WP loaded with a NSNF canister. 13. Drop of a WP inner lid from the WP docking cell crane into a loaded naval WP. ***Fires:*** 1. Electrical fire associated with SNF handling equipment in the WP docking cell, and the WP loading (NSNF canister)/docking ring removal cell (including the overhead cranes, etc.).	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls or shield doors to protect against radiation. 4. Failure of airlock doors for airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
14. DTF: ***NSNF Processing*** WP/Navy Cask Preparation Room, WP Docking Cell, WP Loading (Naval Canister)/Docking Ring Removal Cell (Continued)	***Fires:*** 2. Electrical fire associated with the trolley holding either a loaded, unsealed WP or a loaded NSNF cask holding a NSNF canister. 3. N/S 4. Overheating of a loaded, unsealed (and uninerted) cask or WP due to a loss of cooling resulting in excessive temperature and possible damage to canister contents. 5. Transient combustible fire in the WP docking cell, or the WP loading (naval canister)/docking ring removal cell. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Inadvertent opening of a shield door, leading to a worker exposure. 4. N/S ***Criticality:*** 1. Criticality associated with a NSNF cask drop or collision and rearrangement of cask internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
15. DTF: ***Transfer*** Cask and MSC Docking Room, Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell	***Drops, Slap Downs, Collisions:*** 1. Drop or collision of handling equipment into or against an open cask or open MSC loaded with CSNF assemblies, a DOE HLW canister, a DOE SNF MCO, or a DOE SNF canister. 2. Drop or collision of an SNF assembly from the spent fuel transfer machine back into or against a cask or MSC being unloaded. 3. Drop or collision of an SNF assembly from the spent fuel transfer machine back onto or against one or more SNF assembly(ies) in a cask or MSC. 4. Impact due to horizontal movement of an SNF assembly by the spent fuel transfer machine before the assembly is completely removed from the cask or MSC. 5. Drop of an SNF assembly from the spent fuel transfer machine onto the waste transfer cell floor. 6. Collision involving an SNF assembly suspended from the spent fuel transfer machine with equipment located in the waste transfer cell or on the cell floor (such as lid lifting equipment). 7. Drop or collision of an SNF assembly from the spent fuel transfer machine onto or against a sharp object. 8. Drop or collision of an SNF assembly from the spent fuel transfer machine into or against an empty WP or MSC being loaded. 9. Drop and slap down of an SNF assembly from the spent fuel transfer machine (due to impact with an edge of the cask, MSC, WP, floor edge, WP internal baffle, staging rack, etc.) during the transfer from the cask or MSC to a WP or staging rack. 10. Drop or collision of an SNF assembly from the spent fuel transfer machine onto or against another SNF assembly in a WP or MSC. 11. Drop or collision of a SNF assembly from the spent fuel transfer machine into or against an empty staging rack in the waste transfer cell. 12. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against one or more SNF assemblies in a staging rack. 13. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against a DOE HLW canister or DOE SNF canister in a staging rack. 14. Drop or collision of a DOE HLW canister or a DOE SNF canister from the waste transfer cell overhead crane back into or against the cask or MSC being unloaded.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, view ports or shield doors to protect against radiation. 4. Failure of airlock doors , or view ports to provide airborne confinement 5. Failure/collapse of spent fuel transfer machine.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
15. DTF: ***Transfer*** Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell	***Drops, Slap Downs, Collisions:*** 15. Drop or collision of a DOE SNF MCO from the waste transfer cell overhead crane back into or against the cask being unloaded. 16. Impact due to horizontal of a DOE HLW canister or a DOE SNF canister with the waste transfer cell overhead crane before the canister is completely removed from the cask or MSC. 17. Impact due to horizontal of a DOE SNF MCO with the waste transfer cell overhead crane before the canister is completely removed from the cask. 18. Drop and slap down of a DOE HLW canister or a DOE SNF canister from the waste transfer cell overhead crane (due to impact with an edge of the cask, MSC, WP, floor edge, WP internal baffle, staging rack, etc.) during the transfer from the cask or MSC to a WP, or staging rack. 19. Drop and slap down of a DOE SNF MCO from the waste transfer cell overhead crane (due to impact with an edge of the cask, WP, floor edge, WP internal baffle, etc.) during the transfer from the cask to a WP. 20. Drop or collision of a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the waste transfer cell overhead crane onto or against a sharp object. 21. Collision involving a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO suspended from the waste transfer cell overhead crane with equipment located in the waste transfer cell or on the cell floor, such as lid lifting equipment. 22. Drop of a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the waste transfer cell overhead crane onto the waste transfer cell floor. 23. Drop or collision of a DOE HLW canister or a DOE SNF canister from the waste transfer cell crane into or against an empty canister staging rack. 24. Drop or collision of a DOE HLW canister or a DOE SNF canister from the waste transfer cell crane into or against an SNF assembly staging rack loaded with SNF assemblies. 25. Drop or collision of a DOE HLW canister or a DOE SNF canister from the waste transfer cell crane onto or against another DOE HLW canister or DOE SNF canister in a staging rack. 26. Drop or collision of a DOE HLW canister or a DOE SNF canister from the waste transfer cell crane into or against an empty WP or into or against an empty MSC being loaded.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
15. DTF: ***Transfer*** Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell (Continued)	***Drops, Slap Downs, Collisions:*** 27. Drop or collision of a DOE SNF MCO from the waste transfer cell crane into or against an empty WP being loaded. 28. Drop or collision of a DOE HLW canister from the waste transfer cell crane onto or against another DOE HLW canister in a WP or in an MSC being loaded. 29. Drop or collision of a DOE HLW canister from the waste transfer cell crane onto or against another DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO in a WP being loaded. 30. Drop or collision of a DOE SNF canister from the waste transfer cell crane onto or against a DOE HLW canister in a WP or in an MSC. 31. Drop or collision of a DOE SNF MCO from the waste transfer cell crane onto or against another DOE SNF MCO or a DOE HLW canister in a WP being loaded. 32. Drop or collision of a DOE SNF canister from the waste transfer cell crane onto or against another DOE SNF canister in a WP or in an MSC in a misload situation. 33. Drop or collision of a DOE SNF MCO from the waste transfer cell crane onto or against a DOE SNF canister in a WP in a misload situation. 34. Drop or collision of a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the waste transfer cell crane onto or against SNF assemblies in a WP or in an MSC in a misload situation. 35. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against a DOE HLW canister or a DOE SNF canister in a WP or in an MSC in a misload situation. 36. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO in a WP in a misload situation. 37. Drop or collision of handling equipment onto or against SNF in the SNF staging rack. 38. Drop or collision of handling equipment onto or against a DOE HLW canister or a DOE SNF canister in a canister staging rack. 39. Drop or collision of handling equipment into or against an open MSC or an open WP filled with SNF assemblies.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
15. DTF: ***Transfer*** Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell (Continued)	***Drops, Slap Downs, Collisions:*** 40. Drop or collision of handling equipment into or against an open WP loaded with DOE HLW canisters, and/or a DOE SNF canister, and/or DOE SNF MCOs. 41. Drop or collision of a WP inner lid or MSC cask inner lid from the docking station crane onto or against a loaded WP or loaded MSC. 42. Drop or collision of a WP docking port plug from the waste transfer cell crane onto or against the inner lid of a loaded WP or loaded MSC (with lid in place but not sealed). 43. Drop or collision of a WP docking ring onto or against a loaded WP (with lid in place but not sealed) during docking ring removal in the WP loading/docking ring removal cell. 44. Drop or collision of a handling or other miscellaneous equipment onto or against a loaded WP (with lid in place but not sealed) during docking ring removal in the WP looking/docking ring removal cell. 45. Derailment of a trolley holding a loaded, unsealed WP (with lid in place but not sealed) followed by a load tipover or fall. ***Fires:*** 1. N/S 2. Electrical fire associated with SNF and HLW handling equipment or other electrically powered equipment in the waste transfer cell, the WP docking cell, or the WP loading/docking ring removal cell (including the overhead cranes and the spent fuel transfer machine). 3. Fire/explosion (battery/electrical fire) associated with a cask trolley holding an unsealed, partially-filled or filled cask or MSC. 4. Electrical fire associated with a WP trolley holding an unsealed, partially-filled or filled WP 5. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 6. Transient combustible fire in the cask and MSC docking room, in the waste transfer cell, the WP docking cell, or the WP loading/docking ring removal cell.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
15. DTF: ***Transfer*** Waste Transfer Cell, WP Docking Cell, WP Loading/Docking Ring Removal Cell (Continued)	***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Docking ring failure leads to a radiological release. 3. N/S 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne contamination. 5. N/S 6. Inadvertent opening of a shield door, leading to a worker exposure. 7. N/S ***Criticality:*** 1. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine into a cask, MSC, or WP and a rearrangement of the cask, MSC, or WP internals. 2. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine and a rearrangement of the fuel rods that comprise the assembly due to impact. 3. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine onto the storage racks and a rearrangement of the orientation of the SNF assemblies in the storage racks. 4. Criticality associated with a drop or slap down of a DOE SNF canister, a DOE SNF MCO, or a DOE HLW canister. 5. Criticality associated with the drop of heavy equipment onto a loaded, unsealed cask, MSC, or WP and a rearrangement of the container internals. 6. N/S 7. N/S 8. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
16. DTF: ***Empty Transportation Cask/ MSC/DPC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Restoration Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule	***Drops, Slap Downs, Collisions:*** None identified. ***Fires*** None identified. ***Radiation:*** 1. Radiation exposure of a facility worker. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. ***Criticality:*** 1. N/S	***Seismically-Unique:*** 1. Collapse of structure.
17. DTF: ***Loaded MSC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Preparation Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule	***Drops, Slap Downs, Collisions:*** 1. Derailment of a trolley holding a loaded MSC on a pedestal followed by a load tipover or fall (before or after the outer lid [as applicable] is fastened). 2. Derailment of a trolley holding a loaded MSC on a pedestal due to a turntable malfunction followed by a load tipover or fall (before or after the outer lid [as applicable] is fastened). 3. Collision of a trolley holding a loaded MSC on a pedestal with the shield doors separating the cask and MSC docking room and the cask/MSC turntable room or the cask/MSC turntable room and the cask preparation room (before or after the outer lid [as applicable] is fastened). 4. Closure of the shield doors separating the cask and MSC docking room and the cask/MSC turntable room or the cask/MSC turntable room and the cask preparation room onto the trolley holding a loaded MSC on a pedestal (before or after the outer lid [as applicable] is fastened). 5. Collision involving two trolleys holding casks on pedestals (including a loaded MSC) (before or after the outer lid [as applicable] is fastened). 6. Drop or collision of tools or equipment (including the outer lid-lifting fixture, inner lid-lifting fixture, lid bolts, etc.) onto or against an MSC inner lid or outer lid, as applicable, during the MSC lid fastening process. 7. Drop of an MSC outer lid from the overhead crane onto the loaded MSC inner lid, as applicable.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, view ports or shield doors to protect against radiation. 4. Failure of airlock doors to provide airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
17. DTF: ***Loaded MSC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Preparation Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 8. Drop or collision of a docking ring onto or against a loaded MSC. 9. Collision of a trolley holding a loaded, sealed MSC on a pedestal with shield doors separating cask/MSC turntable room and the cask and MSC to trolley transfer room. 10. Closure of the shield doors separating cask/MSC turntable room and the cask and MSC to trolley transfer room onto the trolley holding a loaded, sealed MSC on a pedestal. 11. Drop of a loaded, sealed MSC from the overhead crane onto the floor during the transfer of the MSC from a pedestal staged on a trolley to the floor in the lay-down area in the cask and MSC SRTC receipt area. 12. Drop or collision of a loaded MSC from the overhead crane onto or against a sharp object during the transfer of the MSC from a pedestal staged on a trolley to the floor in the lay-down area in the cask and MSC SRTC receipt area. 13. Slap down of a loaded, sealed MSC following a drop onto the edge of the pedestal, trolley, railcar or other object during the transfer of the MSC from a pedestal staged on a trolley to the floor in the lay-down area in the cask and MSC SRTC receipt area. 14. Drop or collision of handling equipment from the overhead bridge crane onto or against a loaded MSC. 15. Drop or collision of equipment from the 25 ton material handling onto or against a loaded, sealed MSC. 16. Forklift collision with a loaded, sealed MSC on a pedestal on a trolley, an MSC positioned on the floor in the lay-down area in the cask and MSC SRTC receipt area, or with the MSC transporter holding the MSC. 17. Mobile elevating platform collision with a loaded, sealed MSC on a pedestal on a trolley, an MSC positioned on the floor in the lay-down area in the cask and MSC SRTC receipt area, or with the MSC transporter holding the MSC. 18. Drop of a loaded MSC from the MSC transporter onto the floor inside the DTF while in-transit to the SNF Aging System. 19. Drop or collision of a loaded MSC from the MSC transporter onto or against a sharp object inside the DTF while in-transit to the SNF Aging System. 20. MSC transporter collision while carrying a loaded, sealed MSC followed by an MSC tipover or fall.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
17. DTF: ***Loaded MSC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Preparation Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 21. MSC transporter collision into a loaded, sealed MSC followed by an MSC tipover or fall. 22. Collision of the MSC transporter (holding a loaded, sealed MSC) with the cask and MSC SRTC receipt area shield doors or the cask and MSC entrance vestibule doors. 23. The cask and MSC SRTC receipt area shield doors or the cask and MSC entrance vestibule doors close on the MSC transporter holding a loaded, sealed MSC. ***Fires:*** 1. Electrical fire associated with the overhead cranes, including those located in the cask and MSC docking room, and the cask and MSC SRTC receipt area. 2. Electrical fire associated with handling equipment or other equipment located in the cask and MSC docking room, cask/MSC turntable room, cask and MSC to trolley transfer room, cask preparation room, cask and MSC SRTC receipt area, or the cask and MSC entrance vestibule (including the turntables). 3. Transient combustible fire in the cask and MSC docking room, cask/MSC turntable room, cask preparation room, cask and MSC to trolley transfer room, cask and MSC SRTC receipt area, or the cask and MSC entrance vestibule. 4. Fire/explosion (battery/electrical fire) associated with the cask trolley. 5. Fire/explosion (battery/electrical fire) associated with a forklift. 6. Fire/explosion (battery/electrical fire) associated with a mobile elevating platform. 7. Diesel fuel fire/explosion involving an MSC transporter holding a loaded MSC. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of cask inerting system leading to a release of MSC internal gases. 3. Expansion of gases in the loaded, unsealed MSC, leading to radiological release. 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
17. DTF: ***Loaded MSC Removal*** Cask and MSC Docking Room, Cask/MSC Turntable Room, Cask Preparation Room, Cask and MSC to Trolley Transfer Room, Cask and MSC SRTC Receipt Area, Cask and MSC Entrance Vestibule (Continued)	***Criticality:*** 1. Criticality associated with an MSC collision or trolley derailment followed by a load tipover or fall and a rearrangement of the MSC internals (before or after the outer lid [as applicable] is fastened). 2. Criticality associated with a drop or slap down of a loaded, sealed MSC from an overhead crane and a rearrangement of cask internals. 3. Criticality associated with an MSC transporter collision while holding a loaded, sealed MSC followed by a load tipover or fall and rearrangement of the cask internals.	See prior page.
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley holding the loaded, unsealed WP and the shield doors between the WP loading/docking ring removal cell and the WP handling and staging cell. 2. Shield doors between the WP loading/docking ring removal cell and the WP handling and staging cell close on the trolley holding the loaded, unsealed WP. 3. Derailment of a trolley holding a loaded, unsealed WP followed by a load tipover or fall. 4. Drop of a loaded, unsealed WP from the WP handling and staging cell overhead crane onto the floor during the transfer from the waste transfer area pedestal and trolley to a WP positioning cell pedestal and trolley. 5. Drop of a loaded, unsealed WP from the WP handling and staging cell overhead crane onto a pedestal on a trolley during the transfer from the waste transfer area pedestal and trolley to a WP positioning cell pedestal and trolley. 6. Drop or collision of a loaded, unsealed WP from the WP handling and staging cell overhead crane onto or against a sharp object during the transfer from the waste transfer area pedestal and trolley to a WP positioning cell pedestal and trolley. 7. Slap down of a loaded, unsealed WP from the WP handling and staging cell overhead crane (due to impact with a curb/berm/impact limiter used to maintain drop height limits) or pedestal edge during the transfer from the waste transfer area pedestal and trolley to a WP positioning cell pedestal and trolley.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, view ports or shield doors to protect against radiation. 4. Failure of airlock doors or view ports to provide airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room (Continued)	***Drops, Slap Downs, Collisions:*** 8. Drop or collision of equipment (handling equipment, etc.) from the WP handling and staging cell overhead crane onto or against a loaded, unsealed WP positioned on a pedestal on a trolley. 9. Collision involving the trolley holding the loaded, unsealed WP and the shield doors between WP handling and staging cell and the WP positioning cell. 10. Shield doors between the WP handling and staging cell and the WP positioning cell close on the trolley holding the loaded, unsealed WP. 11. Lid drop onto a WP from the lid placement fixture equipment during the welding process. 12. Equipment drop onto a WP during the welding process. 13. Drop or collision of equipment (handling equipment, etc.) from the WP handling and staging cell overhead crane onto or against a loaded, sealed WP positioned on a pedestal on a trolley. 14. Collision involving the trolley holding the loaded, sealed WP and the shield doors between the WP positioning cell and the WP handling and staging cell. 15. Shield doors between the WP positioning cell and the WP handling and staging cell close on the trolley holding the loaded, sealed WP. 16. Derailment of a trolley holding a loaded, sealed WP on the rails leading from the WP positioning cell, followed by a load tipover or fall. 17. Drop of a loaded, sealed WP from the WP handling and staging cell overhead crane onto the floor during transfer from the WP positioning cell pedestal and trolley to the WP survey station. 18. Drop or collision of a loaded, sealed WP from the WP handling and staging cell overhead crane onto or against a sharp object during transfer from the WP positioning cell pedestal and trolley to the WP survey station. 19. Drop of a loaded, sealed WP from the WP handling and staging cell overhead crane onto the floor during the transfer from the WP survey station to a trolley for transfer to the WP loadout cell or during transfer to a position in a vertical orientation in a storage location in the WP handling and staging cell. 20. Drop of a loaded, sealed WP from the WP handling and staging cell overhead crane onto a trolley during the transfer from the WP survey station to a trolley for transfer to the WP loadout cell.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room (Continued)	***Drops, Slap Downs, Collisions:*** 21. Drop or collision of a loaded, sealed WP from the WP handling and staging cell overhead crane onto or against a sharp object during transfer from the WP survey station to a trolley for transfer to the WP loadout cell or during transfer to a position in a vertical orientation in a storage location in the WP handling and staging cell. 22. Slap down of a loaded, sealed WP from the WP handling and staging cell overhead crane (due to impact with a curb/berm/impact limiter used to maintain drop height limits) or trolley edge during transfer from the WP survey station to a trolley for transfer to the WP loadout cell or during transfer to a position in a vertical orientation in a storage location in the WP handling and staging cell. 23. Drop or collision of equipment (handling equipment, etc.) from the WP handling and staging cell overhead crane onto or against a loaded, sealed WP positioned in a vertical position in a storage position in the WP handling and staging cell. 24. Drop of a loaded, partially sealed WP (WP with a known weld defect) from the WP handling and staging cell overhead crane onto the floor during the transfer from the WP positioning cell pedestal and trolley to a trolley for transfer to the DPC cutting/WP dry remediation cell. 25. Drop of a loaded, partially sealed WP (WP with a known weld defect) from the WP handling and staging cell overhead crane onto a trolley during the transfer from the WP positioning cell pedestal and trolley to a trolley for transfer to the DPC cutting/WP dry remediation cell. 26. Drop or collision of a loaded, partially sealed WP (WP with a known weld defect) from the WP handling and staging cell overhead crane onto or against a sharp object during transfer from the WP positioning cell pedestal and trolley to a trolley for transfer to the DPC cutting/WP dry remediation cell. 27. Slap down of a loaded, partially sealed WP (WP with a known weld defect) from the WP handling and staging cell overhead crane (due to impact with a curb/berm/impact limiter used to maintain drop height limits) or trolley edge during the transfer from the WP positioning cell pedestal and trolley to a trolley for transfer to the DPC cutting/WP dry remediation cell. 28. Drop of a loaded, sealed WP (WP needing decontamination) from the WP handling and staging cell overhead crane onto the floor during transfer from the WP survey station to a trolley for transfer to the WP/trolley decontamination room.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room (Continued)	***Drops, Slap Downs, Collisions:*** 29. Drop of a loaded, sealed WP (WP needing decontamination) from the WP handling and staging cell overhead crane onto a trolley during transfer from the WP survey station to a trolley for transfer to the WP/trolley decontamination room. 30. Drop or collision of a loaded, sealed WP (WP needing decontamination) from the WP handling and staging cell overhead crane onto or against a sharp object during transfer from the WP survey station to a trolley for transfer to the WP/trolley decontamination room. 31. Slap down of a loaded, sealed WP (WP needing decontamination) from the WP handling and staging cell overhead crane (due to impact with a curb/berm/impact limiter used to maintain drop height limits) or trolley edge during the transfer from the WP survey station to a trolley for transfer to the WP/trolley decontamination room. 32. Collision involving the trolley holding the loaded, sealed, contaminated or decontaminated WP and the shield doors between the WP handling and staging cell and the WP/trolley decontamination room. 33. Shield doors between the WP handling and staging cell and the WP/trolley decontamination room close on the trolley holding the loaded, sealed, contaminated or decontaminated WP. 34. Derailment of a trolley holding the loaded, sealed, contaminated or decontaminated WP in the WP/trolley decontamination room (or on the rails leading to/from this room) followed by a load tipover or fall. 35. Drop or collision of equipment (handling equipment, decontamination equipment etc.) onto or against a loaded, sealed contaminated or decontaminated WP positioned on a trolley in the WP/trolley decontamination room. 36. Drop of a loaded, sealed, decontaminated WP from the WP handling and staging cell overhead crane onto the floor during transfer from the trolley serving the WP/trolley decontamination room to the trolley to the WP loadout cell. 37. Drop of a loaded, sealed, decontaminated WP from the WP handling and staging cell overhead crane onto a trolley during transfer from the trolley serving the WP/trolley decontamination room to the trolley to the WP loadout cell. 38. Drop or collision of a loaded, sealed, decontaminated WP from the WP handling and staging cell overhead crane onto or against a sharp object during transfer from the trolley serving the WP/trolley decontamination room to the trolley to the WP loadout cell.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room (Continued)	***Drops, Slap Downs, Collisions:*** 39. Slap down (tip-over from an elevated surface) of a loaded, sealed, decontaminated WP from the WP handling and staging cell overhead crane (due to impact with a curb/berm/impact limiter used to maintain drop height limits) or trolley edge during the transfer from the trolley serving the WP/trolley decontamination room to the trolley to the WP loadout cell. 40. Drop or collision of equipment (handling equipment, etc.) from the WP handling and staging cell overhead crane onto or against a loaded, sealed or partially sealed (with a known weld defect), contaminated or decontaminated WP positioned on a pedestal on a trolley, on a trolley without a pedestal, or the WP survey station. 41. Derailment of a trolley holding a loaded, sealed WP on the rails leading from the WP handling and staging cell to the WP loadout cell, followed by a load tipover or fall. ***Fires:*** 1. Electrical fire associated with SNF or HLW handling and other electrically powered equipment in the WP handling and staging cell, the WP positioning cells, and the WP closure cells, including the cranes and the welders in the WP closure cells. 2. Electrical fire associated with a trolley holding a loaded WP (unsealed or sealed) 3. Fuel damage by burn-through during welding process/heat damage. 4. Thermal hazard/SNF overheating in a WP during the welding process resulting in excessive cladding temperature and possible zircaloy cladding (or other cladding) unzipping. 5. N/S 6. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 7. Transient combustible fire in the WP handling and staging cells, WP positioning cells, WP closure cells, and the WP/trolley decontamination room. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Glove box leak leads radiological release of airborne contamination. 3. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
18. DTF: ***WP Handling, Welding and Decontamination*** WP Handling and Staging Cell, WP Positioning Cells, WP Closure Cells, and the WP/Trolley Decontamination Room (Continued)	***Radiation:*** 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 5. Inadvertent opening of a shield door, leading to a worker exposure 6. N/S ***Contamination/Flooding:*** 1. N/S 2. Flooding due to rupture of water line or clogging of drain associated with the high pressure water system used for decontamination activities in the WP/Trolley Decontamination Room. ***Criticality:*** 1. Criticality associated with a trolley holding a loaded, sealed or unsealed WP derailment followed by a load tipover or fall and a rearrangement of the container internals. 2. Criticality associated with a drop or slap down of a loaded, unsealed WP and a rearrangement of the container contents (including SNF assemblies that may move out of the WP). 3. Criticality associated with the drop of heavy equipment onto a loaded, unsealed WP and a rearrangement of the container internals. 4. Criticality associated with a drop or slap down of a loaded, sealed WP and a rearrangement of the container internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
19. DTF: ***WP Loadout*** WP Loadout Cell, WP Transporter Vestibule, Exit Vestibule	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley holding the loaded, sealed WP and the shield doors between the WP handling and staging cell and the WP loadout cell. 2. Shield doors between the WP handling and staging cell and the WP loadout cell close on the trolley holding the loaded, sealed WP. 3. Derailment of a trolley in the WP loadout cell holding a loaded, sealed WP followed by a load tipover or fall. 4. Drop of a loaded, sealed WP from the WP loadout cell overhead crane onto the floor during the transfer from the trolley to the tilting machine. 5. Drop of a loaded, sealed WP from the WP loadout cell overhead crane back onto the trolley during the transfer from the trolley to the tilting machine. 6. Drop or collision of a loaded, sealed WP from the WP loadout cell overhead crane onto or against a sharp object (including the tilting machine) during transfer from the trolley to the tilting machine. 7. Slap down (either forward into the WP turntable or backward onto the floor) of a loaded, sealed WP engaged in the tilting machine from the WP loadout cell overhead crane during the lowering of the WP to the horizontal position on the emplacement pallet previously placed on the WP turntable. 8. Collision of the tilting machine against a loaded, sealed WP on an emplacement pallet on the WP Turntable. 9. Equipment drop or collision (including lifting yokes) onto or against a loaded, sealed WP during the process to move the WP from the trolley to the tilting machine. 10. Collision of the WP trunnion collar removal machine and the WP during trunnion collar removal. 11. Drop of trunnion collar from the 100 ton overhead bridge crane in the WP loadout cell onto a WP during trunnion collar removal. 12. Movement of the WP Turntable holding the loaded, sealed WP (positioned on the emplacement pallet) prior to disengagement/removal of the WP trunnion collar removal machine. 13. Collision of the WP transporter or transporter bedplate with the loaded, sealed WP positioned on a emplacement pallet on the WP turntable during movement of the bedplate under the WP turntable.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls or shield doors to protect against radiation. 4. Failure of airlock doors to provide airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
19. DTF: ***WP Loadout*** WP Loadout Cell, WP Transporter Vestibule, Exit Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 14. Drop of the loaded, sealed WP (positioned on an emplacement pallet) onto the transporter bedplate during the lowering of the WP and emplacement pallet from the WP turntable to the transporter bedplate positioned under the turntable. 15. Collision involving a WP transporter (holding the sealed WP on an emplacement pallet) and the shield doors between the WP loadout cell and the WP transporter vestibule. 16. Shield doors between the WP loadout cell and the WP transporter vestibule close on the WP transporter (holding the loaded, sealed WP on an emplacement pallet). 17. Collision involving WP transporter (holding the loaded, sealed WP on an emplacement pallet) and the shield doors between the WP transporter vestibule and the exit vestibule. 18. Shield doors between the WP transporter vestibule and the exit vestibule close on the WP transporter (holding the loaded, sealed WP on an emplacement pallet). 19. Collision involving the WP transporter (holding the loaded, sealed WP on an emplacement pallet) and the doors between the exit vestibule and the ambient air (outside). 20. Doors between the exit vestibule and the ambient air (outside) close on the WP transporter (holding the loaded, sealed WP on a pallet). 21. Derailment of a WP transporter in the exit vestibule, WP transporter vestibule, or WP loadout cell followed by a load tipover or fall. 22. Drop of a heavy load from the maintenance crane in the WP loadout crane park cell onto a loaded, sealed WP. ***Fires:*** 1. Electrical fire associated with the WP loadout cell, the WP transporter vestibule, or the exit vestibule (including the WP collar removal machine, the tilting machine, and the WP turntable). 2. Electrical fire associated with a trolley holding a sealed WP. 3. Electrical fire associated with the WP loadout cell overhead bridge crane.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
19. DTF: ***WP Loadout*** WP Loadout Cell, WP Transporter Vestibule, Exit Vestibule (Continued)	***Fires:*** 4. Electrical fire associated with equipment on the WP transporter, including motors to extend the WP transporter bedplate. 5. Electrical fire associated with the WP transporter locomotive. 6. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 7. Transient combustible fire in the WP loadout cell, the WP transporter vestibule, or the exit vestibule. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Inadvertent opening of a shield door, leading to a worker exposure. 4. Inadvertent opening of the WP transporter shielded enclosure doors, leading to a worker exposure. 5. N/S ***Criticality:*** 1. Criticality associated with a trolley holding a loaded, sealed WP derailment followed by a load tipover or fall and a rearrangement of the container internals. 2. Criticality associated with a drop, slap down, or collision of a loaded, sealed WP and a rearrangement of the container internals. 3. Criticality associated with a WP transporter derailment followed by a load tipover or fall and rearrangement of the WP internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
20. DTF: ***WP Remediation*** DPC Cutting/WP Dry Remediation Cell	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley holding a loaded, partially sealed WP (WP with a known weld defect) and the shield doors between the WP handling and staging cell and the WP/trolley decontamination room or the doors between the WP/trolley decontamination room and the DPC cutting/WP dry remediation cell. 2. Shield doors between the WP handling and staging cell and the WP/trolley decontamination room or the doors between the WP/trolley decontamination room and the DPC cutting/WP dry remediation cell close on the trolley holding a loaded, partially sealed WP (WP with a known weld defect). 3. Derailment of a trolley holding a loaded, partially sealed WP (WP with a known weld defect) followed by a load tipover or fall in the DPC cutting/WP dry remediation cell. 4. Drop of a loaded, partially sealed WP (WP with a known weld defect) from the DPC cutting/WP dry remediation cell overhead crane onto the floor during the transfer from the trolley to the cutting machine base. 5. Drop of a loaded, partially sealed WP (WP with a known weld defect) from the DPC cutting/WP dry remediation cell overhead crane onto the cutting machine base during the transfer from the trolley to the cutting machine base. 6. Drop or collision of a loaded, partially sealed WP (WP with a known weld defect) from the DPC cutting/WP dry remediation cell overhead crane onto or against a sharp object during transfer from the trolley to the cutting machine base. 7. Drop or collision of equipment (including a lifting yoke) from the DPC cutting/WP dry remediation cell overhead crane onto or against a loaded, partially sealed WP (WP with a known weld defect). 8. Drop or collision of the WP/canister cutting machine onto or against the defective WP during the lowering of the machine for the lid-cutting operation. 9. Damage to the WP contents (fuel assembly[ies], canisters, etc.) during lid-cutting operations. 10. Drop or collision of the WP/canister cutting machine onto or against the defective WP during the removal of the machine after the lid-cutting operation. 11. Drop of a severed lid (outer, middle, or inner) back onto the WP from an overhead crane during, or after, the completion of the WP cutting. 12. Drop or collision of handling equipment (lid grapple) onto or against the unsealed (open), loaded WP.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, view ports or shield doors to protect against radiation. 4. Failure of airlock doors, or view ports to provide airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
20. DTF: ***WP Remediation*** DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 13. Drop of an unsealed (open), loaded WP from the overhead crane in the DPC cutting/WP dry remediation cell onto the floor during the transfer of the WP from the cutting machine base to the trolley that travels to the unloading port to the waste transfer cell. 14. Drop of an unsealed (open), loaded WP from the overhead crane in the DPC cutting/WP dry remediation cell onto the trolley during the transfer of the WP from the cutting machine base to the trolley that travels to the unloading port to the waste transfer cell. 15. Drop or collision of an unsealed (open), loaded WP from the overhead crane in the DPC cutting/WP dry remediation cell onto or against a sharp object during transfer of the WP from the cutting machine base to the trolley that travels to the unloading port to the waste transfer cell. 16. Slap down of an unsealed (open), loaded WP following a drop from the overhead crane in the DPC cutting/WP dry remediation cell onto the edge of a pedestal or impact limiter on/near the trolley that travels to the unloading port to the waste transfer cell during the lift and transfer to the trolley. 17. Derailment of a trolley (that travels to the unloading port to the waste transfer cell) holding a loaded WP (in an opened state) in the DPC cutting/WP dry remediation cell followed by a load tipover or fall. 18. Drop or collision of an SNF assembly from the spent fuel transfer machine into or against the WP. 19. Drop or collision of an SNF assembly from the spent fuel transfer machine onto or against another SNF assembly or assemblies in the WP. 20. Impact due to horizontal movement of an SNF assembly by the spent fuel transfer machine before the assembly is fully lifted out of the WP. 21. Drop and slap down of an SNF assembly from the spent fuel transfer machine (due to impact with an edge of the WP, floor edge, WP internal baffle, etc.) during the transfer of the SNF assemblies to a WP or staging rack. 22. Drop or collision of a NSNF canister, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the waste transfer cell overhead crane back into or against the WP being unloaded.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
20. DTF: ***WP Remediation*** DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 23. Impact due to horizontal of a NSNF canister, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO with the waste transfer cell overhead crane before the canister is completely removed from the WP. 24. Drop or collision of a DOE HLW canister from the waste transfer cell crane back onto or against, another DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO in a WP 25. Drop or collision of a DOE SNF canister from the waste transfer cell crane onto or against, a DOE HLW canister in the WP. 26. Drop or collision of a DOE SNF MCO from the waste transfer cell crane onto or against, another DOE SNF MCO or a DOE HLW canister in the WP. 27. Drop and slap down of a DOE HLW canister, a DOE SNF MCO, a DOE SNF canister, or a NSNF canister from the waste transfer cell overhead crane (due to impact with an edge of the WP, floor edge, WP internal baffle, etc.) during the transfer from the WP to a new WP, MSC, or staging rack (if applicable). 28. Drop or collision of handling equipment into or against an opened WP filled with SNF assemblies. 29. Drop or collision of handling equipment into or against an opened WP loaded with a NSNF canister, DOE HLW canisters, and/or DOE SNF canisters, and/or DOE SNF MCOs ***Fires:*** 1. Electrical fire associated with SNF and HLW handling equipment in the DPC cutting/WP dry remediation cell (including the overhead cranes, overhead manipulators, the chipless cutting equipment, etc.). 2. Electrical fire associated with the trolley. 3. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 4. N/S 5. Transient combustible fire in the DPC cutting/WP dry remediation cell.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
20. DTF: ***WP Remediation*** DPC Cutting/WP Dry Remediation Cell (Continued)	***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of the WP sampling and purging system, leading to a release of WP internal gases and radioactive material. 3. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 4. Thermal expansion of gases or other loss of confinement in an unsealed cask, leading to radiological release. 5. N/S ***Criticality:*** 1. Criticality associated with a trolley (holding a partially sealed WP being unloaded requiring remediation) derailment followed by a load tipover or fall and a rearrangement of the container internals. 2. Criticality associated with a drop of an SNF assembly from the waste transfer cell spent fuel transfer machine back into the WP being unloaded and a rearrangement of the WP internals. 3. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine back into a WP being unloaded and a rearrangement of the fuel rods that comprise the assembly due to impact. 4. Criticality associated with a drop or slap down of a WP from the DPC cutting/WP dry remediation cell overhead crane and a rearrangement of the container internals. 5. Criticality associated with a drop or slap down of a NSNF canister, a DOE SNF canister, a DOE SNF MCO, or a DOE HLW canister from the waste transfer cell overhead crane during WP unloading. 6. Criticality associated with a trolley (holding an unsealed, open WP) derailment followed by a load tipover or fall and a rearrangement of the container internals. 7. Criticality associated with the drop of heavy equipment onto an unsealed, open WP and a rearrangement of the container internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley holding the cask or MSC requiring remediation and the shield doors between the cask and MSC docking room and the cask/MSC turntable room, the cask/MSC turntable room and the cask preparation room, the cask preparation room and the DPC preparation/cask dry remediation room, the DPC preparation/dry remediation room and the cask docking/dry remediation room, or the cask docking/dry remediation room and the tool spare transfer room. 2. Shield doors between the cask and MSC docking room and the cask/MSC turntable room, the cask/MSC turntable room and the cask preparation room, the cask preparation room and the DPC preparation/cask dry remediation room, the DPC preparation/dry remediation room and the cask docking/dry remediation room, or the cask docking/dry remediation room and the tool spare transfer room close on the trolley holding the cask or MSC requiring remediation. 3. Derailment of a trolley in the cask and MSC docking room, the cask/MSC turntable room, the cask preparation room, the DPC preparation/cask dry remediation room, the cask docking/dry remediation room, or the tool spare transfer room while holding a cask or MSC, followed by a load tipover or fall. 4. Drop or collision of tools or equipment onto or against a cask or MSC requiring remediation. 5. Collision involving an access platform or a mobile elevating platform (if required) and a cask or MSC requiring remediation. 6. Collision of a trolley holding the cask or MSC requiring remediation with another trolley holding a cask or MSC on the turntable in the DPC docking room or on the tracks leading to the cask docking/dry remediation room or tool spare transfer room. 7. Drop or collision of a docking port (mobile slab) onto or against a cask or MSC. 8. Drop or collision of a docking port plug onto or against a cask lid or MSC lid (with outer lid removed [if applicable] and inner lid unbolted but in place). 9. Drop of an inner lid on a cask or MSC (with outer lid removed [if applicable]). 10. Drop or collision of a grapple or other handling equipment into or against an open cask or MSC loaded with SNF assemblies, a DPC, a DOE HLW canister, a DOE SNF MCO, or a DOE SNF canister. 11. Drop or collision of an SNF assembly from the DPC cutting/WP dry remediation cell crane back into or against a cask or MSC being unloaded	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, view ports or shield doors to protect against radiation. 4. Failure of airlock doors, or view ports to provide airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 12. Drop or collision of an SNF assembly from the DPC cutting/WP dry remediation cell crane onto or against another SNF assembly in a cask or MSC. 13. Impact due to horizontal movement of an SNF assembly by the DPC cutting/WP dry remediation cell crane before the assembly is completely removed from the cask or MSC. 14. Drop of an SNF assembly from the DPC cutting/WP dry remediation cell crane onto the DPC cutting/WP dry remediation cell floor. 15. Collision involving an SNF assembly suspended from the DPC cutting/WP dry remediation cell crane with equipment located in the DPC cutting/WP dry remediation cell or on the cell floor (such as lid lifting equipment). 16. Drop or collision of an SNF assembly from the DPC cutting/WP dry remediation cell crane onto or against a sharp object. 17. Drop or collision of an SNF assembly from the DPC cutting/WP dry remediation cell crane into or against an empty basket located on a trolley in the DPC cutting/WP dry remediation cell. 18. Drop and slap down of an SNF assembly from the DPC cutting/WP dry remediation cell crane (due to impact with an edge of the cask, MSC, basket, floor edge, basket internal baffle, etc.) during the transfer from the cask or MSC to a basket on a trolley in the DPC cutting/WP dry remediation cell. 19. Drop or collision of a SNF assembly from the DPC cutting/WP dry remediation cell crane onto or against one or more SNF assemblies in a basket on a trolley in the DPC cutting/WP dry remediation cell. 20. Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane back into or against the cask or MSC being unloaded, as applicable. 21. Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane back onto or against a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO in the cask or MSC, as applicable. 22. Impact due to horizontal of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO with the DPC cutting/WP dry remediation cell crane before the canister is completely removed from the cask or MSC, as applicable.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 23 Drop and slap down of a DPC, a DOE HLW canister, a DOE SNF MCO, or a DOE SNF canister from the DPC cutting/WP dry remediation cell crane (due to impact with an edge of the cask, MSC, floor edge, basket internal baffle, etc.) during the transfer from the cask or MSC (as applicable) to a basket on a trolley in the DPC cutting/WP dry remediation cell. 24 Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane onto or against a sharp object. 25. Collision involving a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO suspended from the DPC cutting/WP dry remediation cell crane with equipment located in the DPC cutting/WP dry remediation cell or on the cell floor. 26. Drop of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane onto the DPC cutting/WP dry remediation cell floor. 27. Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane into or against an empty basket on a trolley in the DPC cutting/WP dry remediation cell. 28. Drop or collision of a DOE HLW canister from the DPC cutting/WP dry remediation cell crane onto or against another DOE HLW canister, a DOE SNF canister or a DOE SNF MCO in a basket on a trolley in the DPC cutting/WP dry remediation cell. 29. Drop or collision of a DOE SNF canister from the DPC cutting/WP dry remediation cell crane onto or against a DOE HLW canister in a basket on a trolley in the DPC cutting/WP dry remediation cell. 30. Drop or collision of a DOE SNF MCO from the DPC cutting/WP dry remediation cell crane onto or against another DOE SNF MCO or a DOE HLW canister in a basket on a trolley in the DPC cutting/WP dry remediation cell. 31. Drop or collision of handling equipment from the DPC cutting/WP dry remediation cell crane into or against a basket on a trolley in the DPC cutting/WP dry remediation cell filled with SNF assemblies. 32. Drop or collision of handling equipment from the DPC cutting/WP dry remediation cell crane into or against a basket on a trolley in the DPC cutting/WP dry remediation cell loaded with DOE HLW canisters, and/or a DOE SNF canister, and/or DOE SNF MCOs, as applicable.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 33. Drop or collision of handling equipment from the DPC cutting/WP dry remediation cell crane into or against a basket on a trolley in the DPC cutting/WP dry remediation cell loaded with a DPC (if not emptied). 34. Derailment of a trolley (that travels to the unloading port to the waste transfer cell) holding a loaded basket containing SNF assemblies in the DPC cutting/WP dry remediation cell, followed by a load tipover or fall. 35. Derailment of a trolley (that travels to the unloading port to the waste transfer cell) holding a loaded basket containing a DPC (if not emptied), or a combination of DOE HLW canisters, DOE SNF canisters, or DOE SNF MCOs in the DPC cutting/WP dry remediation cell, followed by a load tipover or fall. 36. Drop or collision of a load port cover from the waste transfer cell crane onto or against a loaded basket on a trolley that is being unloaded. 37. Drop or collision of a SNF assembly from the spent fuel transfer machine back into or against the basket on a trolley. 38. Impact due to a horizontal movement of a SNF assembly by the spent fuel transfer machine before the assembly is fully lifted out of the basket on a trolley. 39. Drop and slap down of an SNF assembly from the spent fuel transfer machine (due to impact with an edge of the basket, the floor edge, a basket internal baffle, etc.) during the SNF transfer from the basket on the trolley to a WP or staging rack. 40. Drop or collision of a DPC (if not emptied), a DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO from the waste transfer cell overhead crane back into or against the basket on a trolley being unloaded. 41. Impact due to a horizontal movement of a DPC (if not emptied), a DOE HLW canister, a DOE SNF canister, or DOE SNF MCO with the waste transfer cell overhead crane before the canister is completely removed from the basket on a trolley. 42. Drop or collision of a DOE HLW canister from the waste transfer cell crane back onto or against another DOE HLW canister, a DOE SNF canister, or a DOE SNF MCO in the basket on a trolley. 43. Drop or collision of a DOE SNF canister from the waste transfer cell crane onto or against a DOE HLW canister in the basket on a trolley. 44. Drop or collision of a DOE SNF MCO from the waste transfer cell crane onto or against another DOE SNF MCO or a DOE HLW canister in the basket on a trolley.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 45. Drop and slap down of a DOE HLW canister, a DOE SNF MCO, or a DOE SNF canister from the waste transfer cell overhead crane (due to impact with an edge of the basket, floor edge, basket internal baffle, etc.) during the transfer from the basket on a trolley to a new WP or staging rack (if applicable). 46. Drop or collision of handling equipment from the spent fuel transfer machine into or against a basket on a trolley filled with SNF assemblies. 47. Drop or collision of handling equipment from the waste transfer cell overhead crane into or against a basket on a trolley loaded with DOE HLW canisters, and/or DOE SNF canisters, and/or DOE SNF MCOs, as applicable. ***Fires:*** 1. Electrical fire associated with tools or SNF and HLW handling equipment in the cask docking/dry remediation room, the tool spare transfer room, or the DPC cutting/WP dry remediation cell (including the overhead cranes, overhead manipulators, etc.). 2. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 3. N/S 4. Transient combustible fire in the cask and MSC docking room, the cask/MSC turntable room, the cask preparation room, the DPC preparation/cask dry remediation room, the cask docking/dry remediation room, the tool spare transfer room, or the DPC cutting/WP dry remediation cell. 5. Electrical fire associated with the trolley. 6. Fire/explosion (battery/electrical fire) associated with a mobile elevating platform. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of the cask and MSC sampling and purging system, leading to a release of canister internal gases and radioactive material. 3. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 4. Thermal expansion of gases or other loss of confinement in an unsealed cask or MSC, leading to radiological release.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
21. DTF: ***Dry Remediation*** Cask Docking/Dry Remediation Room, Tool Spare Transfer Room, DPC Cutting/WP Dry Remediation Cell (Continued)	***Radiation:*** 5. N/S ***Criticality:*** 1. Criticality associated with a trolley derailment (holding a cask or MSC requiring remediation) followed by a load tipover or fall and a rearrangement of the container internals. 2. Criticality associated with a drop of an SNF assembly from the DPC cutting/WP dry remediation cell crane back into the cask or MSC being unloaded or drop into a basket on a trolley being unloaded and a rearrangement of the cask, MSC, or basket internals. 3. Criticality associated with a drop or slap down of a NSNF canister, a DOE SNF canister, a DOE SNF MCO, or a DOE HLW canister from DPC cutting/WP dry remediation cell crane during cask or MSC unloading or basket on a trolley loading (as applicable). 4. Criticality associated with a trolley (holding a basket containing SNF assemblies, a NSNF canister, or various combinations of DOE SNF canisters, DOE SNF MCOs, or DOE HLW canisters) derailment followed by a load tipover or fall and a rearrangement of the basket contents. 5. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine back into the basket on a trolley being unloaded and a rearrangement of the basket contents. 6. Criticality associated with a drop of an SNF assembly from the DPC cutting/WP dry remediation cell crane back into the cask or MSC being unloaded or onto the DPC cutting/WP dry remediation cell floor and a rearrangement of the fuel rods that comprise the assembly due to impact. 7. Criticality associated with a drop or slap down of a NSNF canister, a DOE SNF canister, a DOE SNF MCO, or a DOE HLW canister from waste transfer cell crane during the unloading of the basket on a trolley (as applicable). 8. Criticality associated with the drop of heavy equipment (lifting fixture, etc.) onto a basket on a trolley and a rearrangement of the basket contents.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley (holding the cask or MSC to be remediated) and the doors to the cask wet remediation entrance vestibule, the shield doors between the cask wet remediation entrance vestibule and the cask wet remediation/laydown area, or the shield doors between the DPC docking room and the cask wet remediation/laydown area. 2. Doors to the cask wet remediation entrance vestibule, the shield doors between the cask wet remediation entrance vestibule and the cask wet remediation/laydown area, or the shield doors between the DPC docking room and the cask wet remediation/laydown area close on the trolley (holding the cask or MSC to be remediated). 3. Derailment of a trolley in the wet remediation entrance vestibule or the cask wet remediation/laydown area while holding a cask or MSC to be remediated, followed by a load tipover or fall. 4. SRTC derailment involving a loaded cask (with or without impact limiters installed) or MSC. 5. Collision of an SRTC carrying a loaded cask (with or without impact limiters installed) or MSC with the cask wet remediation entrance vestibule doors or the cask wet remediation/laydown area shield doors. 6. Cask wet remediation entrance vestibule doors or the cask wet remediation/laydown area shield doors close on an SRTC carrying a loaded cask (with or without impact limiters installed) or MSC. 7. Collision of a mobile elevating platform with a loaded cask or MSC during removal of personnel barriers and impact limiters (if applicable) or during survey activities. 8. Drop or collision of personnel barriers or impact limiters from the cask wet remediation/laydown area crane onto or against a loaded cask (if applicable). 9. Slap-down of a loaded cask onto an SRTC during upending of the loaded cask to the vertical orientation. 10. Drop and slap-down of a loaded MSC onto an SRTC or the floor during the lift of the loaded MSC off of the SRTC. 11. Drop of a loaded cask or MSC from the overhead bridge crane onto the floor during transfer from the trolley or SRTC to the cask decontamination pit/cask preparation pit.	***Seismically-Unique:*** 1. Collapse of structure. 2. Collapse/fracture of pool wall(s) / liner. 3. Failure of equipment supports. 4. Failure of shield walls, or shield doors to protect against radiation. 5. Failure of airlock doors, or view ports to provide airborne confinement. 6. Failure/collapse of wet remediation fuel handling machine into pool. 7. Failure/collapse of crane(s). 8. (Rapid) failure of pool water supply system. ***Possible 2 over 1:*** 1. Failure of 20 ton crane onto other equipment (including 200 ton crane). 2. Failure of walkway onto other SSCs]

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 12. Drop or collision of a loaded cask or MSC from the overhead bridge crane onto or against a sharp object during transfer from the trolley or SRTC to the cask decontamination pit/cask prep pit. 13. Drop or collision of a loaded cask or MSC from the overhead bridge crane into or against the cask decontamination pit/cask prep pit during transfer from the trolley or SRTC to the cask decontamination pit/cask prep pit. 14. Tipover or slap down of a loaded cask or MSC from the overhead bridge crane into the cask decontamination pit/cask prep pit or onto the floor due to contact with the pit ledge or access platform during transfer from the trolley or SRTC to the cask decontamination pit/cask prep pit. 15. Drop or collision of handling equipment (including the cask lifting yoke, cask skirt, cask skirt lifting beam, and cask immersion rod) onto or against the cask or MSC before or after transfer of the cask to the cask decontamination pit/cask prep pit. 16. Collision involving an access platform and a cask or MSC in the cask decontamination pit/cask prep pit. 17. Drop or collision of the cask lid bolt detorque machine or other cask prep equipment with or against a loaded cask or MSC or cask or MSC inner lid (including a lid-lifting fixture, cask gas sample/purge system equipment, cask cool-down equipment, etc.). 18. Drop of a cask or MSC outer lid from the overhead crane onto the cask or MSC. 19. Drop or collision of a loaded cask or MSC from the overhead bridge crane back into or against a pit during transfer from the cask decontamination pit/cask prep pit into the pool. 20. Drop of a loaded cask or MSC from the overhead bridge crane onto the cell floor during transfer from the cask decontamination pit/cask prep pit into the pool. 21. Drop of a loaded cask or MSC from the overhead bridge crane onto or against a sharp object during transfer from the cask decontamination pit/cask prep pit into the pool. 22. Drop of a loaded cask or MSC from the overhead bridge crane onto the pool floor during transfer from the cask decontamination pit/cask prep pit into the pool. 23. Drop or collision of a loaded cask or MSC from the overhead bridge crane onto or against an empty cask or MSC already in the pool during transfer from the cask decontamination pit/cask prep pit into the pool.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 24. Tipover or slap down of a loaded cask or MSC from the overhead bridge crane (due to impact with the pool edge or ledge/wall in the pool) into the pool during transfer from the cask decontamination pit/cask prep pit into the pool. 25. Drop or collision of handling equipment (or other equipment, including an immersion rod) onto or against the lid of a loaded cask or MSC positioned in the pool prior to, or after, the cask or MSC lid removal or installation process, respectively. 26. Collision involving a lid suspended in the pool from the fuel transfer machine removing (or installing) the cask or MSC lid during the lid removal (or installation) process in the pool. 27. Drop of a cask or MSC inner lid onto or into a loaded cask or MSC from the fuel transfer machine during the lid removal (or installation) process in the pool. 28. Drop or collision of an empty cask or MSC from the overhead bridge crane onto or against the cask or MSC already in the pool (to be unloaded) during the lowering of the empty cask or MSC into the pool. 29. Drop or collision of the cask or MSC lid from the empty cask or MSC onto or against the unsealed (open) cask to be unloaded. 30. Drop or collision of an empty SNF basket onto or against the cask to be unloaded. 31. Drop or collision of an empty or full canister for damaged SNF onto or against the cask being unloaded. 32. Drop or collision of an empty or full canister for damaged onto or against the empty or full SNF basket being loaded). 33. Drop of an SNF assembly onto the pool floor while suspended from the fuel transfer machine during transfer from the cask to the SNF basket or to the empty cask or MSC in the pool. 34. Drop or collision of an SNF assembly onto or against a sharp object while suspended from the fuel transfer machine during transfer from the cask to the SNF basket or to the empty cask or MSC in the pool. 35. Drop or collision of an SNF assembly back into or against the cask or MSC being unloaded while suspended from the fuel transfer machine during transfer from the cask to the SNF basket or to the empty cask or MSC in the pool. 36. Drop or collision of an SNF assembly onto or against another assembly or assemblies in the cask while suspended from the fuel transfer machine during transfer from the cask to the SNF basket or to the empty cask or MSC (n the pool.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 37. Impact due to Impact due to horizontal of an SNF assembly by the fuel transfer machine before the assembly is fully lifted out of the cask or MSC. 38. Drop or collision of an SNF assembly into or against the empty SNF basket in the pool while suspended from the fuel transfer machine during transfer from the cask to an empty location in the SNF basket. 39. Drop or collision of an SNF assembly onto or against another fuel assembly or assemblies in the SNF basket in the pool while suspended from the fuel transfer machine during transfer from the cask to an empty location in the SNF basket. 40. Collision of the fuel transfer machine basket grapple with a filled SNF basket during the closing (or opening) of the SNF basket. 41. Drop of a filled SNF basket from the fuel transfer machine onto the pool floor during transfer of the filled SNF basket to (or from) the pool area basket storage rack. 42. Drop or collision of a filled SNF basket from the fuel transfer machine onto or against a sharp object during transfer of the filled SNF basket to (or from) the pool area basket storage rack. 43. Drop or collision of a filled SNF basket from the fuel transfer machine onto, into, or against the cask or MSC being unloaded or loaded (containing SNF) during transfer of the filled SNF basket to or from the pool area basket storage rack. 44. Drop or collision of a filled SNF basket from the fuel transfer machine onto or against an empty basket storage rack location during transfer of the filled SNF basket to (or from) the pool area basket storage rack. 45. Drop or collision of a filled SNF basket from the fuel transfer machine onto or against a filled basket storage rack location (onto another filled SNF basket) during transfer of the filled SNF basket to (or from) the pool area basket storage rack. 46. Drop or collision of handling equipment from the fuel transfer machine onto or against an SNF assembly or assemblies in the SNF basket (before or after transfer to pool area basket storage rack). 47. Drop of an SNF assembly onto the pool floor while suspended from the fuel transfer machine during transfer to an empty cask or MSC from the SNF basket. 48. Drop of an SNF assembly onto or against a sharp object while suspended from the fuel transfer machine during transfer to an empty cask or MSC from the SNF basket. 49. Impact due to horizontal movement of an SNF assembly by the fuel transfer machine before the assembly is fully lifted out of the SNF basket.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 50. Drop or collision of an SNF assembly back into or against the SNF basket being unloaded in the pool while suspended from the fuel transfer machine during transfer to an empty cask or MSC. 51. Drop or collision of an SNF assembly onto or against another assembly or assemblies in the SNF basket in the pool while suspended from the fuel transfer machine during transfer to an empty cask or MSC. 52. Drop or collision of a SNF assembly into or against an empty MSC in the pool while suspended from the fuel transfer machine during transfer to an empty location in a cask or MSC from the SNF basket. 53. Drop or collision of a SNF assembly onto or against another fuel assembly or assemblies inside the MSC in the pool while suspended from the fuel transfer machine during transfer to an empty location in a cask or MSC from the SNF basket. 54. Drop or collision of an empty SNF basket onto or against a filled cask or MSC during movement of the empty SNF basket (after closure of the basket) back to the pool area basket storage rack. 55. Drop or collision of handling equipment or a lid (or other equipment), either from the overhead bridge crane, maintenance crane, or from the fuel transfer machine, onto or against an SNF assembly or assemblies in an open unsealed cask or MSC positioned at the bottom of the pool. 56. Drop or collision of handling equipment (or other equipment) from the overhead bridge crane onto or against a loaded cask or MSC positioned at the bottom of the pool after the lid has been installed, prior to removal from the pool. 57. Drop of a loaded cask or MSC from the overhead bridge crane onto the pool floor during transfer from the pool to the cask decontamination pit/cask prep pit. 58. Drop or collision of a loaded cask or MSC from the overhead bridge crane onto or against a sharp object in the pool during transfer out of the pool to the cask decontamination pit/cask prep pit. 59. Tipover or slap down of a loaded cask or MSC into the cask decon. pit/cask prep pit from the overhead bridge crane due to impact with the pit edge or access platform in the pit during transfer from the pool to the cask decon. pit/cask prep pit. 60. Tipover or slap down of a loaded cask or MSC into the from the overhead bridge crane due to impact with the pool edge or ledge/wall in the pool during transfer from the pool to the cask decon. pit/cask prep pit.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 61. Drop or collision of a loaded cask or MSC from the overhead bridge crane into or against the cask decontamination pit/cask prep pit during transfer from the pool to the cask decontamination pit/cask prep pit. 62. Drop of a loaded cask or MSC from the overhead bridge crane onto the wet remediation area floor during transfer from the pool to the cask decon. pit/cask prep pit or from the cask decontamination pit/cask prep pit to a trolley. 63. Drop of a loaded cask or MSC from the overhead bridge crane onto the trolley during the transfer from the cask decontamination pit/cask prep pit to a trolley. 64. Drop or collision of a loaded cask or MSC from the overhead bridge crane onto or against a sharp object in the cask wet remediation/laydown area during transfer from the pool to the cask decontamination pit/cask prep pit or from the cask decontamination pit/cask prep pit to a trolley. 65. Slap down of a loaded cask or MSC following a drop from the overhead bridge crane (due to contact with the edge of a trolley or trolley pedestal) during the lift from the cask decontamination pit/cask prep pit to the trolley. 66. Drop or collision of an unloaded cask from the overhead bridge crane onto or against a loaded cask or MSC in the pool during transfer of the empty cask from the pool. 67. Collision involving an access platform and a loaded cask or MSC in the cask decontamination pit/cask prep pit. 68. Drop of a cask or MSC outer lid from the overhead crane onto the loaded cask or MSC. 69. Drop or collision of the cask or MSC handling equipment (including the lifting yoke, cask skirt, cask skirt lifting beam, etc.), the lid bolt torque machine, dry vacuum equipment, leak test equipment, flushing equipment, etc., or other cask preparation or decontamination equipment, onto or against a loaded cask or MSC or cask or MSC inner lid. 70. Drop or collision of handling equipment (including the cask lifting yoke) onto or against a cask or MSC before or after transfer of the loaded, sealed cask or MSC to the trolley. 71. Derailment of a trolley holding a loaded, sealed cask or MSC followed by a load tipover or fall.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 72. Collision of a trolley holding a loaded, sealed, remediated cask or MSC with the shield doors separating the cask wet remediation/laydown area and the DPC docking room. 73. Shield doors separating the cask wet remediation/laydown area and the DPC docking room close on a trolley holding a loaded, sealed, remediated cask or MSC. ***Fires:*** 1. Electrical fires associated with the vacuum drier, pool water makeup equipment, or other pool-related equipment. 2. Electrical fire associated with SNF and HLW handling equipment or other associated equipment in the cask wet remediation/laydown area and cask wet remediation entrance vestibule (including the cask lid bolt detorque device, the turntable, overhead manipulators, overhead bridge cranes, the fuel transfer machine, etc.). 3. Fire/explosion (battery/electrical fire) associated with the trolley. 4. Fire/explosion (battery/electrical fire) associated with the mobile elevating platform. 5. Diesel fuel fire/explosion involving an SRTC tractor pushing an SRTC holding a transportation cask or MSC into the cask wet remediation entrance vestibule. 6. Overheating of SNF due to loss of pool water, including events that could lead to such a loss, including the breakdown of the pool water cooling system, resulting in excessive cladding temperature and possible zircaloy cladding (or other cladding) unzipping. 7. N/S 8. N/S 9. Intact or non-intact SNF overheating due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 10. N/S. 11. Transient combustible fire in the cask wet remediation/laydown area or the cask wet remediation entrance vestibule.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Radiation:*** 1. Damage or rupture of the cask sampling and purging system, leading to a release of internal gases and radioactive material. 2. Uncontrolled pool water drain down / fill or leak of pool cooling or water treatment system resulting in flooding and radioactive contamination of adjoining areas. 3. N/S 4. Radiation exposure of a facility worker and/or the offsite public. 5. Loss of confinement zone due to a ventilation system malfunction or other breach of a confinement barrier leading to a release of radiation. 6. N/S 7. Thermal expansion of gases or other loss of confinement in an unsealed cask or MSC, leading to radiological release. 8. N/S ***Criticality:*** 1 Criticality associated with a derailment of a trolley moving a loaded cask followed by a load tipover or fall and a rearrangement of the container internals. 2. Criticality associated with a derailment of an SRTC holding a loaded cask or MSC followed by a load tipover or fall and a rearrangement of the container internals. 3. Criticality associated with a drop, slap down, or collision of a cask or an MSC (when handled with an over head crane) and a rearrangement of the container internals. 4. Criticality associated with a drop of an SNF assembly while unloading a transportation cask, loading cask or MSC, or filling or emptying an SNF basket in the pool, and a rearrangement of SNF in the cask, MSC, or basket. 5. Criticality associated with a drop of an SNF assembly from the fuel transfer machine (in the pool) and a rearrangement of the fuel rods that comprise the assembly due to impact. 6. N/S. 7. N/S 8. Criticality associated with the drop of a spent fuel assembly basket holding several SNF assemblies in the pool (including a drop onto another basket) and a rearrangement of the contents of the basket or baskets.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
22. DTF: ***Wet Remediation*** Cask Wet Remediation / Laydown Area, Cask Wet Remediation Entrance Vestibule (Continued)	***Criticality:*** 9. Criticality associated with the drop of heavy equipment onto a loaded fuel basket (either a single basket or several baskets in a basket storage rack) and a rearrangement of the contents of the basket or baskets. 10. Criticality associated with the drop of heavy equipment onto a loaded cask or MSC and a rearrangement of the container internals (either in or out of the pool). ***Contamination/Flooding:*** 1. Uncontrolled pool water down resulting in flooding (including a down resulting from a puncture of the pool liner due to a cask drop). 2. N/S 3. Cask decontamination pit/cask prep pit flooding due to pool overfill, flooding, pool equipment malfunction, cask preparation system (cask cooling) equipment malfunction, etc. 4. Uncontrolled water spill from the cask decontamination system or the cask preparation system (cask cooling) in the cask wet remediation/laydown area. 5. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
23. DTF: ***DPC Cutting*** DPC Preparation/Cask Dry Remediation Room, DPC Docking Room, DPC Cutting/WP Dry Remediation Cell	***Drops, Slap Downs, Collisions:*** 1. Collision involving the trolley holding the cask containing the loaded DPC and the shield doors between the cask preparation room and the DPC preparation/cask dry remediation room. 2. Shield doors between the cask preparation room and the DPC preparation/cask dry remediation room close on the trolley holding the cask containing the loaded DPC. 3. Derailment of a trolley in the DPC preparation/cask dry remediation room or DPC docking room while holding a cask containing a loaded DPC followed by a load tipover or fall. 4. Drop or collision of a docking ring (or tools, or equipment) onto or against the cask containing the DPC. 5. Collision involving the docking ring station or other access platforms and a cask containing a loaded DPC in the DPC preparation/cask dry remediation room. 6. Collision involving a trolley holding the cask containing the loaded DPC and the shield doors between DPC preparation/cask dry remediation room and the DPC docking room. 7. Shield doors between the DPC preparation/cask dry remediation room and the DPC docking room close on a trolley holding the cask containing the loaded DPC. 8. Derailment of a trolley holding the cask containing the loaded DPC on the turntable in the DPC docking room followed by a load tipover or fall. 9. Collision of a trolley holding the cask containing the loaded DPC with another trolley holding a cask on the turntable in the DPC docking room. 10. Drop or collision of a docking port (mobile slab) onto or against a cask containing the loaded DPC. 11. Drop or collision of a docking port plug onto or against the lid of a cask containing the loaded DPC (with outer lid removed [if applicable] and inner lid unbolted but in place). 12. Drop of an inner lid on a cask containing the loaded DPC (with outer lid removed [if applicable]). 13. Drop or collision of DPC handling device or tools or equipment onto or against the DPC during the drilling/installation of the DPC handling device.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, or shield doors to protect against radiation. 4. Failure of airlock doors, or view ports to provide airborne confinement 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
23. DTF: ***DPC Cutting*** DPC Preparation / Cask Dry Remediation Room, DPC Docking Room, DPC Cutting / WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 14. Drop or collision of a loaded DPC from the DPC Cutting/WP Dry Remediation Cell overhead crane through the unload port back into or against the transportation cask being unloaded during the DPC transfer from the transportation cask to the DPC cutting/WP dry remediation cell cutting machine base. 15. Drop of a loaded DPC from the DPC Cutting/WP Dry Remediation Cell overhead crane onto the floor during DPC transfer from the transportation cask to the DPC cutting/WP dry remediation cell cutting machine base. 16. Drop of a loaded DPC from the DPC Cutting/WP Dry Remediation Cell overhead crane onto the cutting machine base during DPC transfer from the transportation cask to the DPC cutting/WP dry remediation cell cutting machine base. 17. Drop or collision of a loaded DPC from the DPC Cutting/WP Dry Remediation Cell overhead crane onto or against a sharp object during DPC transfer from the transportation cask to the DPC cutting/WP dry remediation cell cutting machine base. 18. Drop or collision of the lid-cutting machine onto or against the DPC during the lowering of the machine for the lid-cutting operation. 19. Damage to one or more fuel assembly(ies) during lid-cutting operations or the DPC drainpipe cutting operation. 20. Drop or collision of the DPC cutting machine onto or against the open (lidless) DPC during the removal of the machine after the lid-cutting operation. 21. Drop or collision of the severed lid back onto or against the open DPC from the ceiling-mounted manipulator or overhead crane after the completion of the DPC lid-cutting. 22. Drop or collision of handling equipment (lid grapple, etc.) onto or against the unsealed (open) loaded DPC. 23. Drop of an unsealed (open), loaded DPC from the overhead crane in the DPC cutting/WP dry remediation cell onto the floor during the transfer of the DPC from the DPC cutting machine base to the trolley that travels to the unloading port to the waste transfer cell. 24. Drop of an unsealed (open), loaded DPC from the overhead crane in the DPC cutting/WP dry remediation cell onto the trolley during the transfer of the DPC from the DPC cutting machine base to the trolley that travels to the unloading port to the waste transfer cell.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
23. DTF: ***DPC Cutting*** DPC Preparation / Cask Dry Remediation Room, DPC Docking Room, DPC Cutting / WP Dry Remediation Cell (Continued)	***Drops, Slap Downs, Collisions:*** 25. Drop or collision of an unsealed (open), loaded DPC from the overhead crane in the DPC cutting/WP dry remediation cell onto or against a sharp object during the transfer of the DPC from the DPC cutting machine base to the trolley that travels to the unloading port to the waste transfer cell. 26. Slap down of an unsealed (open), loaded DPC following a drop from the overhead crane in the DPC cutting/WP dry remediation cell onto the edge of a trolley that travels to the unloading port to the waste transfer cell during the lift and transfer to the trolley. 27. Derailment of a trolley (that travels to the unloading port to the waste transfer cell) holding a loaded DPC (in an unsealed, opened state) in the DPC cutting/WP dry remediation cell, followed by a load tipover or fall. 28. Drop or collision of a load port cover from the waste transfer cell crane onto or against the DPC being unloaded. 29. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against another SNF assembly or assemblies in the DPC being unloaded. 30. Impact due to horizontal movement of a SNF assembly by the spent fuel transfer machine before the assembly is fully lifted out of the DPC. 31. Drop or collision of a SNF assembly from the spent fuel transfer machine onto or against a sharp object (other than another SNF assembly). 32. Drop and slap down of an SNF assembly from the spent fuel transfer machine (due to impact with an edge of the DPC, the floor edge, a DPC internal baffle, etc.) during the SNF transfer from the DPC to a WP or staging rack. ***Fires:*** 1. Electrical fire associated with SNF handling equipment in the DPC preparation/dry remediation room, DPC docking room, the waste transfer cell, or the DPC cutting/WP dry remediation cell (including the overhead cranes, overhead manipulators, the chipless cutting equipment, etc.). 2. Fire/explosion (battery/electrical fire) associated with the cask-handling trolley. 3. Electrical fire associated with the trolley in the DPC cutting/WP dry remediation cell. 4. Intact or non-intact SNF overheating due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
23. DTF: ***DPC Cutting*** DPC Preparation / Cask Dry Remediation Room, DPC Docking Room, DPC Cutting / WP Dry Remediation Cell (Continued)	***Fires:*** 5. N/S 6. Transient combustible fire in the DPC preparation/dry remediation room, DPC docking room, the waste transfer cell, or the DPC cutting/WP dry remediation cell. ***Radiation:*** 1. N/S 2. Damage or rupture of the DPC sampling and purging system, leading to a release of canister internal gases and radioactive material. 3. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 4. Thermal expansion of gases or other loss of confinement in an unsealed cask, leading to radiological release. 5. N/S ***Criticality:*** 1. Criticality associated with a derailment of a trolley moving a transportation cask holding a sealed, loaded DPC and a rearrangement of the DPC contents followed by a load tipover or fall. 2. Criticality associated with a drop or slap down of a sealed, loaded DPC from the DPC Cutting/WP Dry Remediation Cell overhead crane and a rearrangement of the DPC contents. 3. Criticality associated with a drop or slap down of an unsealed (open) loaded, or sealed (unopened) loaded DPC from DPC cutting area overhead crane and a rearrangement of the DPC contents. 4. Criticality associated with a derailment of a trolley moving an unsealed (open) loaded DPC followed by a load tipover or fall and a rearrangement of the DPC contents. 5. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine back into the DPC being unloaded and a rearrangement of the canister internals. 6. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine and a rearrangement of the fuel rods that comprise the assembly due to impact.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
23. DTF: ***DPC Cutting*** DPC Preparation / Cask Dry Remediation Room, DPC Docking Room, DPC Cutting / WP Dry Remediation Cell (Continued)	***Criticality:*** 7. Criticality associated with the drop of heavy equipment onto an unsealed (open) loaded, or sealed (unopened) loaded DPC and a rearrangement of the container internals.	See prior page.
24. FHF: ***Cask and MSC Receipt*** Entrance Vestibule	***Drops, Slap Downs, Collision:*** 1. Railcar derailment, overturning, or collision involving a loaded cask followed by a load tipover or fall. 2. Overturning or collision involving an LWT or OWT holding a loaded cask (with impact limiters and personnel barrier installed). 3. Collision of a railcar, an LWT, or OWT carrying a loaded cask (with impact limiters and personnel barrier installed)with the entrance vestibule doors. 4. The entrance vestibule doors close on a railcar, an LWT, or an OWT carrying a loaded cask (with impact limiters and personnel barrier installed). 5. Collision of the gantry crane carrying a loaded MSC with the entrance vestibule doors. 6. The entrance vestibule doors close on the entrance vestibule gantry crane carrying a loaded MSC. 7. Collision of a mobile elevating platform with a loaded cask or the conveyance holding the cask during removal of personnel barriers and impact limiters or during survey activities. 8. Drop or collision of personnel barriers or impact limiters from the entrance vestibule gantry crane onto or against the loaded cask. 9. Collision between a forklift and a loaded cask on a railcar, an LWT, an OWT, or the conveyance holding the cask, prior to or after the removal of impact limiters and personnel barrier. 10. Collision between a mobile elevating platform and a loaded cask on a railcar, an LWT, an OWT, or the conveyance holding the cask. 11. Collision between the entrance vestibule gantry crane carrying a loaded MSC and a forklift.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
24. FHF: ***Cask and MSC Receipt*** Entrance Vestibule (Continued)	***Drops, Slap Downs, Collision:*** 12. Collision between the entrance vestibule gantry crane carrying the loaded MSC and a mobile elevating platform. 13. Drop or collision of equipment from the entrance vestibule gantry crane (including handling equipment for personnel barriers, impact limiters, etc.) onto or against a loaded cask or loaded MSC. 14. Slap down of a loaded cask onto a railcar, a truck trailer, or the floor during upending of the cask to the vertical orientation (after removal of the impact limiters and personnel barrier). 15. Drop of a loaded cask in a horizontal position (such as the Hi Star) from the entrance vestibule gantry crane onto the floor or back onto the railcar or truck trailer during the transfer from a railcar or truck trailer to the tilting frame. 16. Drop or collision of a loaded cask in a horizontal position (such as the Hi Star) from the entrance vestibule gantry crane onto or against a sharp object or the tilting frame during the transfer from a railcar or truck trailer to the tilting frame. 17. Drop of a loaded cask from the entrance vestibule gantry crane onto the floor during the transfer from a railcar, truck trailer, or tilting frame to the pedestal on an import/export trolley. 18. Drop of a loaded cask from the entrance vestibule gantry crane onto the pedestal on an import/export trolley during the transfer from a railcar, truck trailer, or tilting frame to the pedestal on an import/export trolley. 19. Drop or collision of a loaded cask from the entrance vestibule gantry crane onto or against a sharp object during the transfer from a railcar, truck trailer, or tilting frame to the pedestal on an import/export trolley. 20. Drop of a loaded MSC from the entrance vestibule gantry crane onto the floor during the transfer from the FHF pad to the pedestal on an import/export trolley. 21. Drop of a loaded MSC from the entrance vestibule gantry crane onto the pedestal on an import/export trolley during the transfer from the FHF pad to the pedestal on an import/export trolley. 22. Drop or collision of a loaded MSC from the entrance vestibule gantry crane onto or against a sharp object during the transfer from the FHF pad to the pedestal on an import/export trolley. 23. Slap down of a loaded cask in the entrance vestibule due to off-center cask lowering or drop onto the pedestal on an import/export.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
24. FHF: ***Cask and MSC Receipt*** Entrance Vestibule (Continued)	***Drops, Slap Downs, Collision:*** 24. Slap down of a loaded MSC in the entrance vestibule due to off-center MSC lowering or drop onto the pedestal or edge of the pedestal on an import/export trolley. 25. Handling equipment drop onto a loaded cask or loaded MSC. ***Fire:*** 1. Electrical fire associated with the entrance vestibule gantry crane. 2. Electrical fire associated with handling equipment or other entrance vestibule electrical equipment. 3. Fire/explosion (battery/electrical fire) involving a site prime mover pulling or pushing a conveyance holding a loaded cask. 4. Fire/explosion (battery/electrical fire) associated with the import/export trolley. 5. Fire/explosion (battery/electrical fire) associated with a forklift. 6. Fire/explosion (battery/electrical fire) associated with the mobile elevating platform. 7. N/S 8. Transient combustible fire in the entrance vestibule. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. N/S ***Criticality:*** 1. Criticality associated with a railcar (holding a loaded cask) derailment or collision followed by a load tipover or fall and rearrangement of the cask internals. 2. Criticality associated with an overturning or collision involving an LWT or an OWT holding a loaded cask and rearrangement of cask internals. 3. Criticality associated with a drop or slap down of a cask and a rearrangement of the container internals. 4. Criticality associated with a drop or slap down of an MSC and a rearrangement of the container internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
24. FHF: ***Cask and MSC Receipt*** Entrance Vestibule (Continued)	***Criticality:*** 5. Criticality associated with collision of the entrance vestibule gantry crane holding an MSC followed by a load drop or tipover and a rearrangement of the MSC internals.	See prior page.
25. FHF: ***Preparation*** Preparation Room	***Drops, Slap Downs, Collision:*** 1. Collision of a loaded cask or loaded MSC on a pedestal on the import/export trolley with the preparation room shield doors separating the FHF entrance vestibule from the preparation room. 2. The preparation room shield doors separating the FHF entrance vestibule from the preparation room close on a loaded cask or loaded MSC on a pedestal on the import/export trolley. 3. Derailment of an import/export trolley holding a loaded cask or loaded MSC on a pedestal (with outer and/or inner lid bolted in place, if applicable) followed by a load tipover or fall. 4. Drop or collision of tools or equipment (including a lid-lifting fixture, lid bolts, etc.) onto or against a loaded cask or loaded MSC outer lid (if applicable) or a cask or MSC inner lid in the preparation room. 5. Collision of a mobile elevating platform with a loaded cask or loaded MSC during preparation activities on top of the cask or MSC. 6. Drop of a cask or MSC outer lid onto the loaded cask or loaded MSC (if applicable) in the preparation room. 7. Derailment of an import/export trolley holding a loaded cask or loaded MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) followed by a load tipover or fall. 8. Collision of an import/export trolley holding a loaded cask or loaded MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) with shield doors separating the preparation room and the main transfer room 9. Closure of the shield doors separating the preparation room and the main transfer room onto the import/export trolley holding a loaded cask or loaded MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place).	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls or shield doors to protect against radiation.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
25. FHF: ***Preparation*** Preparation Room (Continued)	***Fire:*** 1. Electrical fire associated with handling equipment or other preparation room equipment. 2. Fire/explosion (battery/electrical fire) associated with the trolley. 3. Fire/explosion (battery/electrical fire) associated with the mobile elevating platform. 4. Transient combustible fire in the preparation area. 5. N/S 6. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of cask sampling and purging system, leading to a release of cask internal gases and radioactive material. 3. N/S 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. ***Criticality:*** 1. Criticality associated with a loaded cask or loaded MSC collision or trolley derailment followed by a load tipover or fall and a rearrangement of the cask internals.	See prior page.
26. FHF: ***Empty WP / Empty MSC Processing*** Entrance Vestibule, Preparation Room, Main Transfer Room, and Fuel Transfer Bay	None Identified	None Identified

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
27. FHF: ***CSNF Assembly Transfer*** Main Transfer Room, Fuel Transfer Bay, Fuel Transfer Room	***Drops, Slap Downs, Collision:*** 1. Derailment of the import/export trolley holding a loaded cask or loaded MSC on a pedestal (with inner lid in place, unbolted) followed by a load tipover or fall. 2. Drop of a loaded cask or MSC (with inner lid in place, unbolted) onto the floor during the lift using the overhead bridge crane from the import/export trolley to the cask transfer trolley or MSC trolley, respectively. 3. Drop of a loaded cask or MSC (with inner lid in place, unbolted) onto the trolley during the lift using the overhead bridge crane from the import/export trolley to the cask transfer trolley or MSC trolley, respectively. 4. Drop or collision of a loaded cask or MSC (with inner lid in place, unbolted) onto or against a sharp object during the lift using the overhead bridge crane from the import/export trolley to the cask transfer trolley or MSC trolley, respectively. 5. Slap down of a loaded cask or MSC (with inner lid in place, unbolted) following a drop from the overhead bridge crane onto the edge of the pedestal, trolley, or other object during the transfer from the import/export trolley to the cask transfer trolley or MSC trolley, respectively. 6. Drop or collision of a docking ring onto or against a loaded cask or loaded MSC prior to entering the fuel transfer bay for unloading. 7. Collision of a mobile elevating platform with a loaded cask or loaded MSC during docking ring or installation activities associated with the cask or MSC prior to entering the fuel transfer bay for unloading. 8. Drop or collision of a manipulator, handling equipment, or other miscellaneous equipment onto or against a loaded cask or loaded MSC prior to entering the fuel transfer bay for unloading. 9. Derailment of the cask transfer trolley or MSC trolley holding a loaded cask or loaded MSC, respectively, on a pedestal (with inner lid in place, unbolted) followed by a load tipover or fall. 10. Collision of a trolley holding a loaded cask or loaded MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place) with the shield doors separating the main transfer room and the fuel transfer bay 11. Closure of the shield doors separating the main transfer room and the fuel transfer bay onto the trolley holding a loaded cask or loaded MSC on a pedestal (with outer lid removed [if applicable] and inner lid unbolted but in place).	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, shield windows or shield doors to protect against radiation. 4. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
27. FHF: ***CSNF Assembly Transfer*** Main Transfer Room, Fuel Transfer Bay, Fuel Transfer Room (Continued)	***Drops, Slap Downs, Collision:*** 12. Drop or collision of a docking port with or against a cask or MSC. 13. Drop or collision of a docking port plug onto or against a cask lid or MSC lid (with outer lid removed [if applicable] and inner lid unbolted but in place). 14. Drop of an inner lid onto a cask or MSC (with outer lid removed [if applicable]). 15. Drop or collision of an SNF assembly from the spent fuel transfer machine back into or against a cask or MSC being unloaded. 16. Drop or collision of an SNF assembly from the spent fuel transfer machine onto or against one or more SNF assembly(ies) in the cask or MSC being unloaded or onto one or more SNF assembly(ies) in the WP or MSC being loaded. 17. Impact due to horizontal movement of an SNF assembly by the spent fuel transfer machine before the assembly is completely removed from the cask or MSC. 18. Drop of an SNF assembly from the spent fuel transfer machine onto the fuel transfer room floor. 19. Collision involving an SNF assembly suspended from the spent fuel transfer machine with wall-mounted equipment located in the fuel transfer room. 20. Drop or collision of an SNF assembly from the spent fuel transfer machine onto or against a sharp object. 21. Drop or collision of an SNF assembly from the spent fuel transfer machine into or against an empty WP or MSC being loaded. 22. Drop and slap down of an SNF assembly from the spent fuel transfer machine (due to impact with an edge of the cask, MSC, WP, floor edge, WP internal baffle, etc.) during the transfer from the cask or MSC to a WP or MSC. 23. Drop or collision of handling equipment into or against an open MSC or an open WP filled with SNF assemblies. 24. Drop of a WP inner lid or MSC cask inner lid (as appropriate) from the fuel transfer room crane onto a loaded WP or loaded MSC. 25. Drop or collision of a transfer port seal plug from the fuel transfer room crane onto or against the inner lid of a loaded WP or a loaded MSC. ***Fire:*** 1. Electrical fire associated with SNF handling equipment or other electrically powered equipment in the main transfer room, the fuel transfer bays, or the fuel transfer room (including the overhead cranes and the spent fuel transfer machine).	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
27. FHF: ***CSNF Assembly Transfer*** Main Transfer Room, Fuel Transfer Bay, Fuel Transfer Room (Continued)	***Fire:*** 2. Fire/explosion (battery/electrical fire) associated with a cask transfer trolley or an MSC trolley holding a filled or partially filled cask or MSC, respectively, with or without inner lid in place (but not sealed). 3. Electrical fire associated with a WP trolley holding a partially filled or filled WP, with or without inner lid in place (but not sealed). 4. Fire/explosion (battery/electrical fire) associated with the mobile elevating platform. 5. N/S 6. Intact or non-intact SNF overheating due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 7. N/S 8. Transient combustible fire in the main transfer room, the fuel transfer bays, or the fuel transfer room. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Docking ring failure leads to a radiological release. 3. N/S 4. Thermal expansion of gases or other loss of confinement in an unsealed cask or MSC, leading to radiological release. 5. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne contamination. 6. Inadvertent opening of a fuel transfer bay door, leading to a worker exposure. 7. N/S ***Criticality:*** 1. Criticality associated with a drop or slap down of a loaded, unsealed cask or MSC from the main transfer room overhead crane and a rearrangement of the container internals. 2. Criticality associated with an import/export trolley, a cask transfer trolley, or an MSC trolley holding a loaded, unsealed cask or MSC (as applicable) derailment followed by a load tipover or fall and a rearrangement of the container internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
27. FHF: ***CSNF Assembly Transfer*** Main Transfer Room, Fuel Transfer Bay, Fuel Transfer Room (Continued)	***Criticality:*** 3. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine into a cask, MSC, or WP and a rearrangement of the cask, MSC, or WP internals. 4. Criticality associated with a drop of an SNF assembly from the spent fuel transfer machine and a rearrangement of the fuel rods that comprise the assembly due to impact. 5. Criticality associated with the drop of heavy equipment onto a loaded, open cask, MSC, or WP and a rearrangement of the container internals. 6. N/S	See prior page.
28. FHF: ***Canister Transfer*** Main Transfer Room	***Drops, Slap Downs, Collision:*** 1. Drop or collision of a loaded cask (with inner lid in place, unbolted) from the main transfer room overhead crane onto the floor during the transfer from a pedestal on the import/export trolley to the cask transfer station. 2. Drop of a loaded cask (with inner lid in place, unbolted) from the main transfer room overhead crane onto or against a sharp object during the transfer from a pedestal on the import/export trolley to the cask transfer station. 3. Drop or collision of a loaded cask (with inner lid in place, unbolted) from the main transfer room overhead crane into or against the canister transfer station. 4. Slap down of a loaded cask (with inner lid in place, unbolted) in the main transfer room due to a cask corner drop from the main transfer room over head crane onto the edge of the pedestal or import/export trolley followed by a slap down. 5. Drop or collision of a loaded cask (with inner lid in place, unbolted) from the main transfer room overhead crane into or against the canister transfer station. 6. Slap down of a loaded cask (with inner lid in place, unbolted) onto the floor, out of the canister transfer station, or into a wall due to off-center cask lowering into the canister transfer station.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, shield windows or shield doors to protect against radiation. 4. Failure of airlock doors or view ports for airborne confinement. 5. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
28. FHF: ***Canister Transfer*** Main Transfer Room (Continued)	***Drops, Slap Downs, Collision:*** 7. Drop or collision of a manipulator, handling equipment, or other miscellaneous equipment onto or against a loaded cask (with inner lid in place, unbolted) prior to entering the canister transfer station for unloading. 8. Drop of a cask inner lid, as appropriate, from the main transfer room overhead crane into a loaded cask to be unloaded. 9. Drop or collision of handling equipment into or against an open cask loaded with a DPC, a DOE HLW canister, a NSNF canister, or a DOE SNF canister. 10. Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a NSNF canister from the main transfer room overhead crane back into or against the cask being unloaded. 11. Impact due to horizontal movement of a NSNF canister, a DPC, a DOE HLW canister, or a DOE SNF canister with the main transfer room overhead crane before the canister is completely removed from the cask. 12. Drop and slap down of a NSNF canister, a DOE HLW canister or a DOE SNF canister from the main transfer room overhead crane into the side of the canister transfer station (due to impact with an edge of the cask, MSC, WP, floor edge, WP or MSC internal baffle, etc.) during the transfer from the cask to a WP or MSC (as appropriate). 13. Drop and slap down of a DPC from the main transfer room overhead crane into the side of the canister transfer station (due to impact with an edge of the cask, MSC, floor edge, MSC internal baffle, etc.) during the transfer from the cask to an MSC. 14. Drop or collision of a DPC, a DOE HLW canister, a DOE SNF canister, or a NSNF canister from the main transfer room overhead crane onto or against a sharp object or edge in the canister transfer station. 15. Drop of a DPC, a DOE HLW canister, a DOE SNF canister, or a NSNF canister from the main transfer room overhead crane onto the canister transfer station floor. 16. Drop or collision of a DOE HLW canister, a DOE SNF canister, or a NSNF canister from the main transfer room crane into or against an empty WP or empty MSC. 17. Drop or collision of a NSNF canister from the main transfer room crane into or against an empty WP. 18. Drop or collision of a DPC from the main transfer room crane into or against an empty MSC.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
28. FHF: ***Canister Transfer*** Main Transfer Room (Continued)	***Drops, Slap Downs, Collision:*** 19. Collision involving a DPC, a DOE HLW canister, a DOE SNF canister, or a NSNF canister and the canister transfer station. 20. Drop or collision of a DOE HLW canister from the main transfer room overhead crane onto or against another DOE HLW canister or a DOE SNF canister in a WP or in an MSC. 21. Drop or collision of a DOE SNF canister from the main transfer room overhead crane onto or against a DOE HLW canister in a WP or in an MSC. 22. Drop or collision of handling equipment into or against an open WP or MSC loaded with a DPC, DOE HLW canisters, and/or DOE SNF canisters, and/or a NSNF canister, as appropriate. 23. Drop of a WP inner lid or MSC cask inner lid, as appropriate, from the main transfer room overhead crane onto a filled (loaded) WP or loaded MSC. ***Fire:*** 1. N/S 2. Electrical fire associated with SNF and HLW handling equipment in the main transfer room (including the overhead crane, manipulators, the movable platform/sleeve assembly, etc.). 3. Fire/explosion (battery/electrical fire) associated with the import/export trolley. 4. Fire/explosion (battery/electrical fire) associated with the mobile elevating platform. 5. N/S 6. Overheating of a loaded cask, WP, or MSC due to a loss of cooling resulting in excessive temperature and possible damage to canister contents. 7. Transient combustible fire in the main transfer room. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne contamination. 3. Thermal expansion of gases or other loss of confinement in an unsealed cask, leading to radiological release. 4. Inadvertent opening of the main transfer room shield door, leading to a worker exposure.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
28. FHF: ***Canister Transfer*** Main Transfer Room (Continued)	***Radiation:*** 5. N/S ***Criticality:*** 1. Criticality associated with a drop or slap down of a loaded cask or MSC from the main transfer room overhead crane and a rearrangement of the cask or MSC internals. 2. Criticality associated with a drop or slap down of a DPC, a DOE SNF canister, a NSNF canister, or a DOE HLW canister and a rearrangement of canister internals. 3. Criticality associated with the drop of heavy equipment onto a loaded, open cask, MSC, or WP and a rearrangement of the container internals. 4. N/S	See prior page.
29. FHF: ***WP Closure*** Main Transfer Room, WP Positioning Cell, WP Closure Cell	***Drops, Slap Downs, Collision:*** 1. Collision involving the trolley holding the loaded, unsealed WP and the shield doors between the main transfer room and the WP positioning cell. 2. Shield doors between the main transfer room and the WP positioning cell close on the trolley holding the loaded, unsealed WP. 3. Derailment of a trolley holding a loaded, unsealed WP followed by a load tipover or fall. 4. Drop or collision of equipment from a main transfer room overhead crane, including a docking ring, lifting equipment, or a lifting fixture, onto or against a loaded, unsealed WP or WP inner lid. 5. Drop or collision of an unsealed, loaded WP from the main transfer room overhead crane back into or against the canister transfer station. 6. Drop of an unsealed, loaded WP from the main transfer room overhead crane onto the main transfer room floor during the lift and transfer to the WP positioning cell pedestal and trolley. 7. Drop of an unsealed, loaded WP from the main transfer room overhead crane onto the pedestal on the WP positioning cell trolley during the lift and transfer to the WP positioning cell pedestal and trolley. 8. Drop or collision of an unsealed, loaded WP from the main transfer room overhead crane onto or against a sharp object during the lift and transfer to the WP positioning cell pedestal and trolley.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, shield doors, or view ports to protect against radiation. 4. Failure of airlock doors or view ports for airborne confinement. 5. Failure/collapse of crane(s) or robotic arm.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
29. FHF: ***WP Closure*** Main Transfer Room, WP Positioning Cell, WP Closure Cell (Continued)	***Drops, Slap Downs, Collision:*** 9. Slap down of a loaded, unsealed WP onto the floor, into a wall, or into nearby equipment following a drop from the main transfer room overhead crane onto the edge of the trolley, pedestal, or other equipment during the lift and transfer to the WP positioning cell pedestal and trolley. 10. Lid drop onto a WP from the lid placement fixture equipment during the welding process. 11. Equipment drop onto a WP during the welding process. 12. Drop or collision of equipment from a main transfer room overhead crane onto or against a loaded, sealed WP positioned on a pedestal on a trolley. 13. Collision involving the trolley holding the loaded, sealed WP and the shield doors between the WP positioning cell and the main transfer room. 14. Shield doors between the WP positioning cell and the main transfer room close on the trolley holding the loaded, sealed WP. ***Fire:*** 1. Electrical fire associated with handling equipment or other electrically powered equipment in the WP closure cell and the WP positioning cell, including the overhead cranes and the welders in the WP closure cell. 2. Electrical fire associated with the WP transfer trolley holding a loaded, unsealed WP or a WP closure transfer trolley holding a loaded, unsealed or sealed WP. 3. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 4. Canister/fuel damage by burn-through during welding process/heat damage. 5. Thermal hazard/canister/SNF overheating in a WP during the welding process resulting in excessive cladding temperature and possible zircaloy cladding (or other cladding) unzipping. 6. Transient combustible fire in the WP closure cell and the WP positioning cell. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Glove box leak leads to a radiological release.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
29. FHF: ***WP Closure*** Main Transfer Room, WP Positioning Cell, WP Closure Cell (Continued)	***Radiation:*** 3. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. ***Criticality:*** 1. Criticality associated with a trolley holding a sealed or unsealed WP derailment followed by a load tipover or fall and rearrangement of the container internals. 2. Criticality associated with a drop or slap down of a loaded, unsealed WP from the main transfer room overhead crane and a rearrangement of the container internals. 3. Criticality associated with the drop of heavy equipment onto a loaded, unsealed WP and a rearrangement of the container internals. 4. Inadvertent opening of a transfer bay shield door or the WP positioning cell shield door, leading to a worker exposure. 5. N/S	See prior page.
30. FHF: ***WP Loadout*** Main Transfer Room, Preparation Room, Entrance Vestibule	***Drops, Slap Downs, Collision:*** 1. Derailment of a trolley holding a loaded, sealed WP followed by a load tipover or fall. 2. Drop of a loaded, sealed WP from a main transfer room overhead crane onto the floor during transfer from the trolley to the survey area or from the survey area to the tilting machine. 3. Drop or collision of a loaded, sealed WP from a main transfer room overhead crane onto or against a sharp object (including the tilting machine) during transfer from the trolley to the survey area or from the survey area to the tilting machine. 4. Slap down of a loaded, sealed WP from a main transfer room overhead crane to the cell floor during transfer from the trolley to the survey area due to drop from the overhead crane onto the edge of the pedestal on the trolley, the edge of the trolley, or another object on the floor. 5. Slap down (either forward into the WP turntable or backward onto the floor) of a loaded, sealed WP in the tilting machine from a main transfer room overhead crane during the lowering of the WP to the horizontal position on the emplacement pallet previously placed on the WP turntable.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, or shield doors to protect against radiation.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
30. FHF: ***WP Loadout*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 6. Collision of the tilting machine against a loaded, sealed WP on an emplacement pallet on the WP turntable. 7. Drop or collision of a lifting collar from a main transfer room overhead crane onto or against a loaded, sealed WP after removal of the collar from the WP collar removal machine. 8. Collision or impact of the lifting collar removal machine and a loaded, sealed WP placed on an emplacement pallet positioned on the WP turntable. 9. Drop of a loaded, sealed WP and emplacement pallet from a main transfer room overhead crane onto the floor during transfer of the WP and emplacement pallet from the WP turntable to the WP transporter bedplate. 10. Drop of a loaded, sealed WP and emplacement pallet from a main transfer room overhead crane onto the WP transporter bedplate during transfer of the WP and emplacement pallet from the WP turntable to the WP transporter bedplate. 11. Drop or collision of a loaded, sealed WP on a emplacement pallet from a main transfer room overhead crane onto or against a sharp object during transfer of the WP and emplacement pallet from the WP turntable to the WP transporter bedplate. 12. Equipment drop or collision (including lifting yokes) onto or against a loaded, sealed WP in the WP transporter load area (including the process to move the WP from the trolley to the WP transporter). 13. Collision involving a WP transporter (holding the sealed WP on an emplacement pallet) and the doors between the main transfer room and the preparation room. 14. The doors between the main transfer room and the preparation room close on the WP transporter (holding the sealed WP on an emplacement pallet). 15. Collision involving WP transporter (holding the sealed WP on an emplacement pallet) and the shield doors between the preparation room and the entrance vestibule. 16. Shield doors between the preparation room and the entrance vestibule close on the WP transporter (holding the sealed WP on an emplacement pallet). 17. Collision involving WP transporter (holding the sealed WP on an emplacement pallet) and the doors between the entrance vestibule and the ambient air (outside). 18. Doors between the entrance vestibule and the ambient air (outside) close on the WP transporter (holding the sealed WP on an emplacement pallet).	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
30. FHF: ***WP Loadout*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 19. Derailment or collision of a WP transporter(holding the sealed WP on a emplacement pallet) in the main transfer room, preparation room, or entrance vestibule followed by a load tipover or fall .***Fires:*** 1. Electrical fire associated with the equipment in the WP transporter load area of the main transfer room, including the WP collar removal machine, the tilting machine, and the WP turntable. 2. Electrical fire associated with the main transfer room overhead cranes. 3. Electrical fire associated with equipment on the WP transporter, including motors to extend the WP transporter bedplate. 4. Electrical fire associated with the WP transport locomotive. 5. Fire/explosion (battery/electrical fire) associated with the WP closure transfer trolley. 6. Intact or non-intact SNF overheating or damage to canister contents due to a loss of cooling resulting in excessive temperature and possible zircaloy cladding (or other cladding) unzipping or cladding failure due to excessive hoop stresses. 7. Transient combustible fire in the main transfer room, preparation room, or the entrance vestibule. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 3. Inadvertent opening of the main transfer room shield door, leading to a worker exposure. 4. Inadvertent opening of the WP transporter shielded enclosure doors, leading to a worker exposure. 5. N/S ***Criticality:*** 1. Criticality associated with a trolley holding a sealed WP derailment followed by a load tipover or fall and rearrangement of the WP internals.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
30. FHF: ***WP Loadout*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Criticality:*** 2. Criticality associated with a drop, slap down, or collision of a sealed WP and a rearrangement of the container internals. 3. Criticality associated with a WP transporter derailment followed by a load tipover or fall and rearrangement of the WP internals.	See prior page.
31. FHF: ***Loaded MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule	***Drops, Slap Downs, Collisions:*** 1. Impact due to horizontal movement of a loaded MSC by the main transfer room overhead crane before it is fully removed from the canister transfer station. 2. Collision of a loaded MSC from the main transfer room overhead crane with the canister transfer station. 3. Drop of an MSC inner or outer lid (as applicable) from the fuel transfer room overhead crane onto the loaded MSC in the fuel transfer bay. 4. Drop or collision of the transfer port plug from the fuel transfer room overhead crane onto or against the inner lid or outer lid of a loaded MSC (as applicable) in the fuel transfer bay or main transfer room (as applicable). 5. Drop of an MSC inner or outer lid (as applicable) from the main transfer room overhead crane onto the loaded MSC in the canister transfer station. 6. Collision of a mobile elevating platform with a loaded MSC during docking ring removal activities associated with the MSC. 7. Collision of a trolley holding a loaded MSC on a pedestal with the shield doors separating the fuel transfer bay and the main transfer room. 8. Closure of the shield doors separating the fuel transfer bay and the main transfer room onto the trolley holding a loaded MSC on a pedestal. 9. Drop or collision of tools or equipment (including the outer lid-lifting fixture, inner lid-lifting fixture [as applicable], lid bolts, etc.) onto or against an MSC inner lid or outer lid (as applicable) during the MSC sealing process. 10. Derailment of a trolley serving a fuel transfer bay or the import/export trolley holding a loaded MSC on a pedestal followed by a load tipover or fall.	***Seismically-Unique:*** 1. Collapse of structure. 2. Failure of equipment supports. 3. Failure of shield walls, or shield doors to protect against radiation. 4. Failure/collapse of crane.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
31. FH:F ***Loaded MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 11. Drop of a loaded MSC from the main transfer room overhead crane onto the floor during the MSC transfer from a pedestal staged on a trolley serving the fuel transfer bay or from the canister transfer station to the import/export trolley and pedestal. 12. Drop of a loaded MSC from the main transfer room overhead crane onto the pedestal on a trolley during the MSC transfer from a pedestal staged on a transfer trolley serving the fuel transfer bay or from the canister transfer station to the import/export trolley and pedestal. 13. Drop or collision of a loaded MSC from the main transfer room overhead crane onto or against a sharp object during the transfer from a pedestal staged on a transfer trolley serving the fuel transfer bay or from the canister transfer station to the import/export trolley and pedestal. 14. Slap down of a loaded MSC following a drop from onto the edge of the pedestal or trolley or other object during the transfer from a pedestal staged on a transfer trolley serving the fuel transfer bay or from the canister transfer station to the import/export trolley and pedestal. 15. Slap down of a loaded MSC onto the floor, into a wall, or into nearby equipment following a drop from the main transfer room overhead crane onto the edge of the import/export trolley, pedestal, or other equipment during the lift and transfer of the MSC from the canister transfer station to the import/export trolley. 16. Collision of the import/export trolley holding a loaded MSC on a pedestal with the shield doors separating the main transfer room and the preparation room or the preparation room and the entrance vestibule. 17. Closure of the shield doors separating main transfer room and the preparation room or the preparation room and the entrance vestibule onto the import/export trolley holding a loaded MSC on a pedestal. 18. Drop or collision of equipment in the preparation room onto or against a loaded MSC on a pedestal on an import/export trolley. 19. Drop of a loaded MSC from the entrance vestibule gantry crane onto the floor during the lifting of the loaded MSC off of the pedestal on the import/export trolley. 20. Drop or collision of a loaded MSC from the entrance vestibule gantry crane onto or against a sharp object during the lifting of the loaded MSC off of the pedestal on the import/export trolley.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
31. FHF: ***Loaded MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Drops, Slap Downs, Collisions:*** 21. Slap down of a loaded, sealed MSC following a drop from the entrance vestibule gantry crane onto the edge of the pedestal, edge of the import/export trolley, or other equipment during the lifting of the loaded MSC off of the pedestal on the import/export trolley. 22. Collision of the entrance vestibule gantry crane holding a loaded MSC with a forklift, mobile elevating platform, or other object in the entrance vestibule. 23. Collision of the entrance vestibule gantry crane holding a loaded MSC with the entrance vestibule doors. 24. The entrance vestibule doors close on the entrance vestibule gantry crane holding a loaded MSC. ***Fires:*** 1. Electrical fire associated with the main transfer room overhead crane , and the entrance vestibule gantry crane. 2. Electrical fire associated with handling equipment or other equipment located in the main transfer room, the preparation room, or the entrance vestibule. 3. Transient combustible fire in the main transfer room, preparation room, or the entrance vestibule. 4. N/S 5. Fire/explosion (battery/electrical fire) associated with the trolley. 6. Fire/explosion (battery/electrical fire) associated with a mobile elevating platform. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Damage or rupture of cask inerting system leading to a release of cask internal gases. 3. N/S 4. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. 5. N/S	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
31. FHF: ***Loaded MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule (Continued)	***Criticality:*** 1. Criticality associated with an MSC trolley collision or trolley derailment followed by a load tipover or fall and a rearrangement of the MSC internals. 2. Criticality associated with a drop or slap down of a loaded MSC from an overhead crane and a rearrangement of cask internals. 3. Criticality associated with the drop of heavy equipment onto an unsealed MSC and a rearrangement of the container internals.	See prior page.
32. FHF: ***Empty Transportation Cask, MSC Removal*** Main Transfer Room, Preparation Room, Entrance Vestibule	***Drops, Slap Downs, Collisions:*** None identified. ***Fires:*** None identified. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. 2. Loss of confinement zone due to ventilation system malfunction or other breach of a confinement barrier leading to a release of airborne radiation. ***Criticality:*** None identified.	***Seismically-Unique:*** None identified.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
33. Subsurface: ***WP Subsurface Transport and Emplacement***	***Drops, Slap Downs, Collisions:*** 1. Collision involving the transport locomotive and the WP transporter (holding the sealed WP on an emplacement pallet) during coupling, prior to entering the North Portal. 2. Derailment of a WP transporter outdoors, prior to entering the north ramp, followed by a load tipover or fall. 3. Derailment of a WP transporter while on the north ramp, in a main drift, or in an emplacement drift turnout, after passing through the North Portal, followed by a load tipover or fall. 4. Runaway of a loaded WP transporter while proceeding down the north ramp. 5. Collision involving a WP transporter (holding a sealed WP on an emplacement pallet) and other stationary or moving equipment. 6. Derailment of a WP transporter at the turnout drift switch, followed by a load tipover or fall. 7. Collision involving a WP transporter (holding the sealed WP on an emplacement pallet) and the emplacement access doors. 8. Emplacement access doors close on the WP transporter (holding the sealed WP on an emplacement pallet). 9. Rockfall onto a WP transporter while in the subsurface. 10. Collision involving a WP transporter (holding the sealed WP on an emplacement pallet) and the emplacement transfer dock (while backing into the dock). 11. WP transporter doors close on the WP on an emplacement pallet. 12. WP rolls or slides out of a WP transporter on the surface (outdoors), in a ramp, in a main drift, or at the entrance of the emplacement drift. 13. WP and emplacement pallet drop from a WP emplacement gantry. 14. Derailment of a WP emplacement gantry holding a WP on an emplacement pallet, followed by a load drop (drop of the WP and emplacement pallet). 15. WP emplacement gantry carrying a WP collides with another WP in the drift. 16. WP emplacement gantry carrying a WP travels to the end of the drift and drops off the end of the rails, falling to the ground below.	***Seismically-Unique:*** 1. Tunnel invert and track distortions. 2. Failure of supports for electrical supply or control system. 3. Portal collapse. 4. Failure of shield walls or doors to protect against radiation. 5. Structural failure of WP transporter, WP emplacement gantry, emplacement pallet

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
33. Subsurface: ***Subsurface WP Transport and Emplacement*** (Continued)	***Drops, Slap Downs, Collisions:*** 17. WP emplacement gantry holding a WP on a emplacement pallet rolls off the emplacement transfer dock and either falls onto the drift rails (or surrounding ground) or impacts the WP transporter (if the transporter has not been moved). 18. Empty WP emplacement gantry rolls off the emplacement transfer dock and falls onto the WP transporter, impacting the WP on the emplacement pallet on the extended bedplate. 19. Collision of a WP emplacement gantry holding a WP on an emplacement pallet with a fallen rock, fallen ground support, or other object, followed by a load drop (drop of the WP and emplacement pallet). 20. Rockfall onto a WP. 21. Rockfall onto a WP emplacement gantry holding a WP on an emplacement pallet. 22. Ground control drop onto a WP. 23. Ground control drop onto a WP emplacement gantry holding a WP on an emplacement pallet. 24. Runaway WP transporter in an emplacement main drift and a collision with the barrier isolating the development side of the repository from the emplacement side of the repository. ***Fires:*** 1. Electrical fire associated with the transport locomotive. 2. Fire/explosion (battery/electrical fire) associated with the transport locomotive. 3. Fire/explosion (battery/electrical fire) associated with the WP emplacement gantry. 4. Electrical fire associated with equipment on the WP transporter, including motors to extend the WP transporter bedplate. 5. Electrical fire associated with the WP emplacement gantry or other subsurface equipment. 6. N/S 7. N/S ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public.	See prior page.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
33. Subsurface: ***Subsurface WP Transport and Emplacement*** (Continued)	***Radiation:*** 2. N/S 3. Release of activated air and dust to the environment. 4. Inadvertent opening of the WP transporter shielded enclosure doors, leading to a worker exposure. 5. N/S 6. Inadvertent opening of the emplacement access doors, leading to a worker exposure. ***Criticality:*** 1. Criticality associated with a drop or collision of a WP and a rearrangement of the container internals. ***Contamination/Flooding:*** 1. Flooding from a water pipe break originating on the development side of the repository (there are no sources of water present in the emplacement side of the repository. 2. N/S	See prior page.
34. SNF Aging System; ***Aging Pads*** [d]	***VERTICAL AGING SYSTEM*** ***MSC Transporter Mechanical/Structural Failure:*** 1. The MSC transporter fails and the vertical cask drops, resulting in damage to the aging system. 2. The MSC transporter fails and tips over, resulting in damage to the aging system. ***Roadway Surface Failure:*** 1. Hole, defect, or weak subsurface or shoulder condition in transfer roadway results in tipover of MSC transporter during transfer of a vertical cask. ***MSC Transporter Control Error:*** 1. The MSC transporter rolls off edge of roadway and is damaged in a tipover event. 2. The MSC transporter collides with vehicles or equipment staged or moving along transfer route causing direct damage, a cask drop, or tipover event. 3. The MSC transporter collides with aging cask or module staged on Aging Pad causing direct damage, a cask drop, or tipover event.	***External Hazard - Induced by Seismic Activity [Designated as Beyond Category 2]*** [d]***:*** 1. SNF Aging System suffers structural damage when subjected to maximum acceleration loadings/interaction impacts 2. SNF Aging System tipovers and suffers structural damage 3. Aging cask or transfer cask is dropped from transporter and damaged during transfer operations. 4. During transfer ram operation resulting in DPC mechanical interaction with HTC and/or HAM rail system and damage to the DPC.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
34. SNF Aging System; ***Aging Pads*** [c] (Continued)	***MSC Transporter Control Error:*** 4. The MSC transporter rolls down inclined roadway and collides with fixed object or tips over. 5. The MSC transporter collides with an aging cask or module causing a volatile fuel of hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 6. The MSC transporter collides with other vehicles causing a volatile fuel of hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 7. The MSC transporter collides with an aging cask or module causing an acid spill (i.e., batteries). Acid or other chloride containing chemical comes in contact with aging system surface and results in damage to the aging system. 8. The MSC transporter collides with other vehicles causing an acid spill (i.e., batteries). Acid or other chloride-containing chemical comes in contact with aging system surface and results in damage to the aging system. 9. The MSC transporter is moved in the wrong direction off the Aging Pad resulting in a tipover and damage to the Aging Cask. 10. The MSC transporter is moved in the wrong direction off the Aging Pad resulting in a tipover and damage to the Aging Cask. ***Incorrect Vent Screen Installation:*** 1. N/S ***Incorrect Temperature Monitoring System Installation Error:*** 1. N/S ***Confinement Barrier Monitoring System Error:*** 1. Malfunctioning confinement barrier monitoring system component results in loss of indication or inaccurate monitoring data being observed and interpreted by surveillance personnel. Inaccurate monitoring data results in a defective aging system seal not being detected and unmonitored radiological releases to occur. ***Vent Temperature Monitoring System Malfunction:*** 1. Malfunctioning vent temperature monitoring system component results in loss of indication or inaccurate monitoring data being observed and interpreted by surveillance personnel. Inaccurate monitoring data results in a defective aging system seal not being detected and unmonitored radiological releases to occur.	***Other Seismically-Unique events:*** 1. Sliding of vertical cask. 2. Collapse of horizontal module structure. 3. Failure of horizontal module shield door radiation.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
34. SNF Aging System; ***Aging Pads*** [c] (Continued)	***Confinement Barrier Monitoring System Failure:*** 1. Malfunctioning confinement barrier monitoring system component results in loss of indication or inaccurate monitoring data being observed and interpreted by surveillance personnel. Inaccurate monitoring data results in a defective aging system seal not being detected and unmonitored radiological releases to occur. ***Seal Welded Confinement Barrier System Failure:*** 1. The failure of seal welds caused by mechanical loads on the system. Radiological release as a result of this event. ***Bolted Closure Confinement System Failure:*** 1. The failure of o-ring seals associated with one of the primary confinement barriers caused by mechanical damage to the closure system (from cask drop or some other hazard). Radiological release as a result of this event. ***Surveillance/Maintenance Vehicle Control Failure:*** 1. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module staged on the Aging Pad during maintenance/surveillance activity on Aging Pad causing direct damage to an aging cask or tipover event. 2. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module causing a volatile fuel of hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 3. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module causing an acid spill (i.e., batteries). Acid or other liquid chemical comes in contact with aging system surface and results in damage to the aging system. ***Welding/Cutting Activities:*** 1. N/S 2. A gas cylinder is dropped, crushed, or tipped over, resulting in an explosion and/or fire that damages an aging system ***Fire:*** 1. Flammable liquids or combustible materials stages or near the Aging Pad ignite. The fire results in damage to the aging system	See prior page

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
34. SNF Aging System; ***Aging Pads*** [c] (Continued)	***HORIZONTAL AGING SYSTEM*** ***HTC Cask Tractor Control Failure*** 1. The HTC Cask Tractor collides with aging cask during attachment procedure causing direct damage or tipover event that damages the DPC. ***HTC Transfer Trailer/Tractor Mechanical/Structural Failure*** 1. The HTC transfer trailer/tractor fails and the HTC drops, resulting in damage to the aging system. 2. The HTC transfer trailer/tractor fails and tips over, resulting in damage to the aging system. ***Roadway Surface Failure:*** 1. Hole, defect, or weak subsurface or shoulder condition in transfer roadway results in tipover of HTC transfer trailer/tractor during transfer of a vertical cask. ***HTC Transfer Trailer/Tractor Control Error:*** 1. The HTC transfer trailer/tractor rolls off edge of roadway and is damaged in a tipover event. 2. The HTC transfer trailer/tractor collides with vehicles or equipment staged or moving along transfer route causing direct damage, a cask drop, or tipover event. 3. The HTC transfer trailer/tractor collides with aging cask or module staged on Aging Pad causing direct damage, a cask drop, or tipover event. 4. The HTC transfer trailer/tractor rolls down inclined roadway and collides with fixed object or tips over. 5. The HTC transfer trailer/tractor and/or Cask Tractor collide with an aging cask or module causing a volatile fuel of hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 6. The HTC transfer trailer/tractor and/or Cask Tractor collide with other vehicles causing a volatile fuel of hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 7. The Cask Tractor collides with an aging cask or module causing an acid spill (i.e., batteries). Acid or other chloride containing chemical comes in contact with aging system surface and results in damage to the aging system. 8. The HTC transfer trailer/tractor is moved in the wrong direction off the Aging Pad resulting in a tipover and damage to the Aging Cask.	See prior page

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
34. SNF Aging System; ***Aging Pads*** [c] (Continued)	***Load Drops:*** 1. The HTC ram access plate cover is dropped from a mobile crane onto the HTC (without impact limiters) causing damage. 2. The HAM shield door is dropped from a mobile crane onto the HTC (without impact limiters), HAM or directly onto a DPC during ram transfer operations, causing damage. ***Surface Contamination:*** 1. N/S ***Hydraulic Ram Hydraulic System Failure:*** 1. The Hydraulic ram hydraulic fluid is released and is ignited. An explosion and/or fire results that damages the aging system. ***DPC Misalignment:*** 1. N/S ***Hydraulic Ram System Malfunction:*** 1. N/S ***Incorrect Seismic Restraint Installation:*** 1. Improper installation of seismic restraint results in damage to DPC following a seismic event. ***Vent Temperature Monitoring System Installation Error:*** 1. N/S ***Vent Temperature Monitoring System Malfunction:*** 1. Malfunctioning temperature monitoring system component results in loss of indication or inaccurate monitoring data being observed and interpreted by surveillance personnel. Inaccurate monitoring data results in a defective aging system seal not being detected and unmonitored damage to contained SNF clad or HLW packing barriers. ***Surveillance/Maintenance Vehicle Control Failure:*** 1. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module staged on the Aging Pad during maintenance/surveillance activity on Aging Pad causing direct damage to an aging cask or tipover event.	See prior page

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	**Internal Events That Could Be Initiated by Seismic Event** [a,b,c]	**Potential Seismically-Unique Events**
34. SNF Aging System; ***Aging Pads*** [c] (Continued)	***Surveillance/Maintenance Vehicle Control Failure:*** 2. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module causing a volatile fuel or hydraulic fuel spill, or hydrogen release (i.e., batteries). An explosion and/or fire results that damages the aging system. 3. An Aging Pad or maintenance/surveillance vehicle collides with an aging cask or module causing an acid spill (i.e., batteries). Acid or other liquid chemical comes in contact with aging system. ***Welding/Cutting Activities:*** 1. N/S 2. A gas cylinder is dropped, crushed, or tipped over, resulting in an explosion and/or fire that damages an aging system. ***Fire:*** 1. Flammable liquids or combustible materials stages or near the Aging Pad ignite. The fire results in damage to the aging system. ***External:*** Loss of Power.	See prior page

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
35. Subsurface Facilities: ***Construction Hazards***	***Drops, Slap Downs, Collision:*** None identified. ***Fire:*** 1. Diesel fuel fire or explosion associated with development equipment resulting in damage to the subsurface isolation barriers. 2. Electrical fire associated with subsurface development equipment or other equipment resulting in damage to the subsurface isolation barriers. 3. Transient combustible fire in the development side of the subsurface facilities resulting in damage to the subsurface isolation barriers. 4. Loss of cooling in the emplacement drifts. ***Criticality:*** None identified. ***Radiation:*** None identified. ***Contamination/Flooding:*** 1. Flooding from a pipe break originating on the development side of the repository (there are no sources of process water present in the emplacement side of the repository).	***Seismically-Unique:*** 1. Collapse / rockfall within exhaust shaft(s) or exhaust tunnels, reversing air flow, leading to a loss of confinement. 2. Failure of isolation airlocks between emplacement and development areas, leading to a release of activated material present in the emplacement side of the repository into the development side of the repository.
36. Surface Facilities: ***Construction Hazards***	***Drops, Slap Downs, Collision:*** 1. Impacts on a loaded transportation cask, a loaded MSC, or a loaded WP as a result of construction operations. ***Fire:*** 1. Diesel fuel fire/explosion associated with construction equipment. 2. Electrical fire associated with construction equipment or other equipment. 3. Transient combustible fire. ***Radiation:*** 1. Radiation exposure of a facility worker and/or the offsite public. ***Criticality:*** 1. Criticality associated with an impact on a loaded transportation cask, a loaded MSC, or a loaded WP and a rearrangement of the container internals.	***Seismically-Unique:*** 1. Collapse of construction cranes or other tall equipment onto surface facilities.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
37. Subsurface Facilities: ***Drip Shield Installation***	***Drops, Slap Downs, Collisions:*** 1. Derailment of a drip shield emplacement gantry carrying a drip shield, followed by a load drop (drop of the drip shield); the drip shield and/or the gantry impacts a WP or several WPs. 2. Drip shield emplacement gantry carrying a drip shield collides with a WP or WPs due to gantry failure. 3. Collision of a drip shield emplacement gantry holding a drip shield with a fallen rock, fallen ground support, or other object, followed by a load drop (drop of the drip shield) onto a WP or WPs. 4. Rockfall onto a drip shield emplacement gantry carrying a drip shield, leading to gantry damage or failure and impact of the rock or drip shield with a WP. 5. Rockfall onto a WP. 6. Ground control drop onto a WP. 7. Ground control drop onto a drip shield emplacement gantry carrying a drip shield, leading to gantry damage or failure and impact of the ground control or drip shield with a WP. ***Fires:*** 1. Electrical fire associated with the drip shield emplacement gantry or other subsurface equipment. 2. N/S ***Radiation:*** 1. Early WP failure while in the subsurface during the preclosure period and a resultant release of radioactive material. 2. Release of activated air and dust to the environment. ***Criticality:*** 1. Criticality associated with an impact or collision with a WP and a rearrangement of the container internals.	***Seismically-Unique:*** None identified.
38. ***Retrieval***	Included in emplacement evaluations.	Included in emplacement evaluations.

Table III-2. Identification of Seismically Initiated Potential Events (Continued)

Functional Areas [a]	Internal Events That Could Be Initiated by Seismic Event [a,b,c]	Potential Seismically-Unique Events
*39. **Site-Generated Radiological Waste Disposal***	***Drops, Slap Downs, Collisions:*** 1. Drop of a heavy load onto a tank, piping, or a container containing liquid radioactive waste. 2. Drop of a container or drum containing solid LLW. ***Fires:*** 1. Transient combustible fire in areas where dry, flammable LLW is stored. ***Radiation:*** 1. Radiation exposure of a facility worker. ***Criticality:*** None identified.	***Seismically-Unique:*** 1. Collapse of disposal structures onto other SSCs ITS.

NOTES: [a] Modified from BSC (2004p).

[b] Numbering of potential internal events is as shown in BSC (2004p). Events, which are not applicable to seismic event initiation, are labeled “N/S” for not applicable.

[c] SNF Aging System listings modified from Cogema (2004).

[d] N/S = Not seismic: excluded as not credible as a seismically-initiated event.

BWR = boiling water reactor; CHF = Canister Handling Facility; CSNF = commercial spent nuclear fuel; DPC = dual-purpose canister; DSNF = U.S. Department of Energy-owned spent nuclear fuel; DTF = Dry Transfer Facility; FHF = Fuel Handling Facility; HAMs = horizontal aging modules; HLW = high-level radioactive waste; ITS = important to safety; MCO = multi-canister overpack; MSC = monitored geologic repository site-specific cask; PWR = pressurized water reactor; SNF = spent nuclear fuel; SRTC = site rail transfer cart; SSCs = structures, systems, and components; WP = waste package.

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ATTACHMENT IV
STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY WITH DBGM ASSIGNMENTS

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ATTACHMENT IV

STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY WITH DBGM ASSIGNMENT

Attached is a table of assignments of DBGM levels to structures, systems, subsystems and components that are classified as important to safety (ITS) that are credited in the prevention or mitigation of a seismically-initiated event sequences. ITS is one division of the SSCs classified as Safety Category (BSC 2004z , Section 4.2.2). The other division of SSCs is termed important to waste isolation. SSCs important to waste isolation are considered in postclosure performance assessment but are not applicable to preclosure safety and therefore are not addressed in this analysis.

The potential doses in Table 3 and the results of the assignments in Table 4 are used as the basis for assignment of DBGM levels to SSC ITS in Table IV-1. In the implementation of these DBGM assignments, not all SSCs that are ITS are assigned a DBGM level. If the specific SSC is not credited in the prevention or mitigation of a credible seismically-initiated event sequence, it is not assigned a DBGM level. Rather, the SSC will be assigned a "conventional design" designation for the seismic design criterion. Therefore, the list contains several SSC ITS that have a "conventional design" assignment.

On another aspect of assigning DBGM levels, certain SSCs may be upgraded from DBGM-1 to DBGM-2 based on considerations of the aggregated DBGM-1 dose. In the event when analysis indicate the aggregated dose due to the failure of all BDGM-1 is equal to or greater than 5 rem TEDE [i.e., non-compliance of aggregated DBGM-1 SSCs doses with 10 CFR 63.111(b)(2)], then one or more DBGM-1 SSCs may be upgraded to a DBGM-2 level to achieve compliance. Further, re-assignment from a DBGM-1 to a DBGM-2 level may also be based on risk informed management or review decisions.

In addition, the table identifies potential seismic interactions. These interactions can cause an SSC to be designated as ITS when examined in detailed design. Any SSC whose failure can cause a SSC classified as ITS to not perform its safety function when required shall be classified as a Safety Category ITS and designed to prevent the unacceptable interaction. Items that potentially can cause such a "two-over-one" interaction are identified in the Table IV-1, based on the current level of design. However, for this analysis, the specific SSC is not re-assigned to ITS, but rather identified for further investigation. In this regard, a small design change, such as changing the SSC location, or by introducing of a barrier or restraint, could remove or change the interaction. For example, if a piping system could fail and strike a SSC ITS, pipe restraints/hangers could be introduced to prevent the displacement. In this case, the restraints would then be designated as SSC-ITS and designed to a DBGM level, and not the piping system. In summary, while seismic interactions are noted, no re-assignment of SSCs is performed as part of seismic interaction in the present analysis.

Table IV-1. Seismic Classification of Systems, Components and Functions

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Balance of Plant Facilities						
Administration Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Security Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Utility Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Emergency Response Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Offsite Facilities	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Materials and Consumables Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Fire Water Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Maintenance and Repair Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Generator Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Switchgear Facility	Structure	Non-SC	N/A	CD	N/A [Potential for Seismic Interaction]	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence. Potential Interaction: SSC houses 4.16 kV switchgear, which controls power for fans supplying air to waste transfer cells requiring continual cooling.
Construction Support Facility	Structure	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.
Central Control Center Facility	Structure	Non-SC	N/A	CD	N/A [Potential for Seismic Interaction]	Collapse of structure due to a seismic event shall not impact waste handling operations or adjacent structures. No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence. Seismically-initiated control function failure could potentially impact a SSC ITS.
Transportation Facility	Truck and Railcar Staging Areas	Non-SC	N/A	CD	N/A	Design loads in compliance with 10 CFR Part 71 bound expected seismic loads for seismically-initiated sequences with transporters with impact limiters.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Canister Handling Facility						
CHF	Structure	SC	ITS	DBGM-2	No Structural Collapse	Collapse of structure due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
CHF	Rails for Trolleys, WP Transporter, and SRTCs	SC	ITS	DBGM-2	No Derailment	Damage to rails and subsequent tipover or slap down of a waste transport due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
CHF	Permanent Shielding (including Shield Doors and Walls, Airlock Doors, Shield View Ports, and Viewing Windows)	SC	ITS	DBGM-1	Shielding Integrity Remains Intact	Loss of shielding due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Cask/ Monitored Geologic Repository Site-Specific Cask/Waste Package Preparation System						
Cask Preparation	200 ton Cask Handling Crane and Rigging (DTF and CHF)	SC	ITS	DBGM-2	No Drop	Drop of cask without impact limiters containing DSNF due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Cask Preparation	200 ton Navy Cask Handling Crane and Rigging (DTF)	SC	ITS	DBGM-2	No Drop	Assigned to DBGM-2 as part of risk-informed basis (Assumption 5.20)
Cask Preparation	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	As part of the crane assembly, the yokes are relied on to minimize the probability of a load drop. Drop of cask without impact limiters containing DSNF due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
Cask Preparation	Turntables	SC	ITS	DBGM-2	No Tipover	Tipover due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
Cask Preparation	Cask Docking Ring	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Cask Preparation	Cask Pit Pedestal	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Cask Preparation	Cask Pit Protective Covers	SC	ITS	DBGM-1	Shielding Integrity Remains Intact	Removal or damage of covers due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Cask Preparation	Pit Crush Pad	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Cask Preparation	200 ton Vestibule Gantry Crane (FHF)	SC	ITS	DBGM-2	No Drop	Drop of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Cask Preparation	200 ton Main Transfer Room Crane (FHF)	SC	ITS	DBGM-2	No Drop	Drop of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. Sharp objects that could result in a breach to a waste form or its container shall not be located under the load path of any crane that handles waste forms or waste containers without appropriate lift height restrictions on the crane.
Cask Preparation	Mobile Elevating Platform	Non-SC	N/A	CD	N/A [Potential for Seismic Interaction]	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Possible platform for interaction with waste container to be examined.
Cask Preparation	Cask Pit Movable Platform	Non-SC	N/A	CD	N/A [Potential for Seismic Interaction]	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Possible platform for interaction with waste container to be examined.
Cask Preparation	Trolleys	SC	ITS	DBGM-2	No Slap Down	A slap down due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function [a,c]**	**Safety Category [a]**	**ITS/ITWI [a]**	**Seismic Category [b]**	**Safety Function (for DBGM Assignment) [d]**	**Basis for Seismic Classification/Comments**
Cask Preparation	Pedestals, and Hold-Down Devices (DTF, CHF, and FHF)	SC	ITS	DBGM-2	No Tipover	A tipover due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
WP Preparation	WP Trolleys (DTF)	SC	ITS	DBGM-2	No Tipover	A tipover due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
WP Preparation	Pedestals, and Hold-Down Devices (DTF)	SC	ITS	DBGM-2	No Slap Down	A slap down due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
WP Preparation	WP Docking Ring	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
WP Preparation	100 ton WP and Canister Handling Crane (CHF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. Sharp objects that could result in a breach to a waste form or its container shall not be located under the load path of any crane that handles waste forms or waste containers without appropriate lift height restrictions on the crane.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
WP Preparation	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	As part of the crane assembly, the yokes are relied on to minimize the probability of a load drop. Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Preparation	Crush Pad	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
WP Preparation	WP Pit Pedestal	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
WP Preparation	WP Pit Protective Cover	SC	ITS	DBGM-1	No Failure	Removal or damage of cover due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
WP Preparation	MSC Pit Pedestal	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
WP Preparation	MSC Pit Protective Cover	SC	ITS	DBGM-1	No Failure	Removal or damage of cover due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Cask Restoration	Entire (Same Components as Cask Preparation Subsystem)	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Cask Receipt and Return System						
SRTC Buffer	SRTC	ITS	N/A	DBGM-2	No Slap Down	In receipt areas, impact limiters are removed from transportation casks while on SRTCs. In this situation, failure of the SSC would involve waste forms without impact limiters, and therefore the potential exists for a seismic event to initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). In most cases, the SRTC will carry transportation casks with impact limiters. Transportation casks <u>with</u> impact limiters are designed to 10 CFR Part 71 requirements, which are assumed to exceed DBGM-2 design loads (Assumption 5.16).
SRTC Buffer	SRTC Rails (and Supports)	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence. SRTC rails and supports are used to transport waste forms in transportation casks with impact limiters within the Transportation Cask Buffer Area. Transportation casks with impact limiters are designed to 10 CFR Part 71 requirements, which exceed 1DBGM-2 design loads (Assumption 5.16).
SRTC Buffer	SRTC Positioner	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Failure of SSC would involve waste forms within transportation casks with impact limiters. Transportation casks with impact limiters are designed to 10 CFR Part 71 requirements, which exceed DBGM-2 design loads (Assumption 5.16).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
SRTC Buffer	SRTC Positioner Turntable	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Failure of SSC would involve waste forms within transportation casks with impact limiters. Transportation casks with impact limiters are designed to 10 CFR Part 71 requirements, which exceed DBGM-2 design loads (Assumption 5.16).
SRTC Buffer	SRTC Tractor	Non-SC	N/A	DBGM-2*	No Slap Down* No Runaway*	Within structures, the tractor may collide with the STRC or mis-direct the SRTC (runaway) and induce slap down of cask without impact limiters due to a seismic event that could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). However, movement of the SRTC (containing casks without impact limiters) by the SRTC tractor is limited to very short distances within structures (DTF, CHF, FHF), and requires reevaluation to determine if a slapdown or runaway is a credible event. *Designation of SSC requires review.
Cask Receipt and Return	250 ton Cask Handling Crane (TCRRF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. Sharp objects that could result in a breach to a waste form or its container shall not be located under the load path of any crane that handles waste forms or waste containers without appropriate lift height restrictions on the crane.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Cask Receipt and Return	Cask Lifting Yokes	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Cask Receipt and Return	Crush Pad	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Communications System						
Communications	Subsystems include: Voice such as Radio, Wired and Mobile Telephone, Public Address; Video; Data; Network; and Transport	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Digital Control and Management Information System						
Digital Control and Management Information	Entire	Non-SC	N/A	CD	N/A [Potential Seismic Interaction]	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Potential loss of control function due to Chatter induced by seismic event; see Section 6.1.3.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
DOE and Commercial Waste Package System						
DOE and Commercial WP System	WP (See also Engineered Barrier System)	SC	ITS / IWTI	DBGM-2	No Breach No Criticality	Breach of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. The system shall ensure that as a result of a seismic event, a nuclear criticality cannot occur.
DOE and Commercial WP System	Trunnion Collar	SC	ITS	DBGM-2	No Drop	Breach of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
DOE Spent Nuclear Fuel Disposable Canister						
DSNF Disposable Canister	Standardized DSNF Canister	SC	ITS	DBGM-2	No Breach	Breach of DSNF Canister due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
DSNF Disposable Canister	DOE Multi-canister Overpack	SC	ITS	DBGM-2	No Breach	Breach of DSNF Canister due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
DSNF Disposable Canister	DOE HLW Canister	SC	ITS	DBGM-1	No Breach	Breach of HLW canister due to a seismic event is taken (conservatively) to exceed the performance objectives of 10 CFR 63.111(b)(1).
DSNF Disposable Canister	Internal Geometry Control (For DSNF Standardized and Multi-canisters, and HLW)	SC	ITS	DBGM-2	No Criticality	The SSC shall ensure that as a result of a seismic event, a nuclear criticality cannot occur.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
DSNF Disposable Canister	Internal Neutron Absorbers	SC	ITWI	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Dry Transfer Facility (Includes Remediation System)						
DTF	Structure	SC	ITS	DBGM-2	No Structural Collapse	Collapse of structure due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
DTF	Remediation Pool	SC	ITS	DBGM-2	No Failure	Failure of pool resulting loss of water due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
DTF	Rails for Trolleys, WP Transporter, and SRTCs	SC	ITS	DBGM-2	No Derailment	Damage to rails and subsequent tipover or slap down of a waste transport due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
DTF	Permanent Shielding (including Shield Doors and Walls, Airlock Doors, Shield View Ports, and Viewing Windows)	SC	ITS	DBGM-1	Shielding Integrity Remains Intact	Loss of shielding due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
DTF	Electro-mechanical manipulators	(Not Assigned)*	(Not Assigned)*	DBGM-2	No Drop	Manipulators will latch/unlatch grapples, connect/disconnect crane attachments, and sort and pack waste into container. Drop of SSCs held by manipulators onto a waste form due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister. *Classification of SSC requires review.
Electrical Power System						
Normal Power, Switchyard and Standby Power, and Emergency Diesel Generators	Entire	Non-SC	N/A	CD	N/A [Potential for Seismic Interaction]	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence. Offsite power failure can be expected due to significant seismic event.
Emergency Power	4.16 kV Emergency Bus, 480 V Emergency Bus, 125 V DC, and 120 V AC UPS	SC	ITS	CD	N/A [Potential for Seismic Interaction]	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. Emergency power failure can be expected due to significant seismic event.
Electrical Support System						
Lighting	Entire	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Grounding	Entire	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Lightning Protection	Entire	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Cathodic Protection	Entire	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Heat Tracing	Entire	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Cable Raceway	Portion that Supports ITS Function of the DTF and FHF Surface Nuclear HVAC Primary Subsystem Components from the Fan Motor to the 4160 V Bus Emergency Power Subsystem	SC	ITS	CD	N/A [Potential for Seismic Interaction]	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Cable Raceway	Portion of the Cable Raceway Subsystem that Supports Normal Power, Switchyard and Standby Power, and Emergency Diesel Generators (including support systems)	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Emplacement and Retrieval System						
WP Transportation	WP Transporter	SC	ITS	DBGM-2	No Runaway (Together with Locomotive and Coupler)	A runaway locomotive due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister. The restraints used to immobilize the bedplate inside the shielding compartment of the transporter and the mechanism for locking the doors of the shielding compartment shall withstand a credible collision or derailment of the transporter without failure.
WP Transportation	WP Transporter	SC	ITS	DBGM-1	Shielding Integrity Remains Intact	Loss of shielding due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
WP Emplacement	WP Emplacement Gantry	SC	ITS	CD	N/A	The slow speed and controls of the gantry shall prevent the waste package emplacement gantry carrying a waste package from impacting another emplaced WP or impacting the end of the emplacement drift (Assumption 5.5). With current emplacement drift dimensions, the design drop height(s) of the WP can not be physically exceeded. Therefore, no slapdown or drop criterion is applied as the sealed WPs cannot exceed height limits and be breached by a seismically-induced event (Assumptions 5.2 and 5.5).
WP Retrieval	Components of this System are the Same as WP Transport and WP Emplacement Systems	Same as Designated in WP Transport and WP Emplace-ment Systems	Same as Designated in WP Transport and WP Emplace-ment Systems	Same as Designated in WP Transport and WP Emplacement Systems	Same as Designated in WP Transport and WP Emplacement Systems	
Support Equipment	Transport Locomotive (and Coupler)	SC	ITS	DBGM-2	No Runaway (Together with WP Transporter)	A runaway locomotive (which could initiate a slap down of WP) due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
Support Equipment	Gantry Carrier	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Emplacement Drift Subsystem						
Emplacement Drift	Emplacement Drift Excavated Opening	SC	ITS/ITWI	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. The opening dimensions will influence the size of a possible rockfall. The WP is designed to withstand the rockfall without breach.
Emplacement Drift	Emplacement Drift Ground Support	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Emplacement Drift	Drift Invert (Steel) (See Engineered Barrier)	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Emplacement Drift	Drift Invert (Ballast) (See Engineered Barrier)	SC	ITWI	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Emplacement Drift	WP Emplacement Pallet	SC	ITWI / ITS	DBGM-2	No Failure	The WP and pallet are lifted as a unit and placed onto the bedplate of the transporter as part of transport to the subsurface. As such, the pallet transfers loads to the WP. Failure of the pallet during a lift could cause a drop of WP due to a seismic event that could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Emplacement Drift	Drip Shield	SC	ITWI	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. See also: Engineered Barrier System.
Emplacement Drift	Drip Shield Emplacement Gantry	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Engineered Barrier System						
Engineered Barrier	Drip Shield	SC	ITWI	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. See also: Emplacement Drift Subsystem.
Engineered Barrier	WP	SC	ITWI / ITS	DBGM-2	No Breach	Release from a DSNF canister due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). See also the DOE, Commercial, and Naval WP System for requirements on entire package.
Engineered Barrier	WP Internals (Internal Geometry Controls)	SC	ITWI / ITS	DBGM-2	No Criticality	The SSC shall ensure that as a result of a seismic event, a nuclear criticality cannot occur. Internal geometry controls prevent in-package criticality for preclosure period.
Engineered Barrier	Waste Form	SC	ITWI	N/A	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. No seismic design criteria identified.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Engineered Barrier	Cladding	SC	ITWI	N/A	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. See the Emplacement Drift System for the Drift Invert ITS preclosure functions.
Engineered Barrier	Drift Invert (Ballast)	SC	ITWI	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. See also: Emplacement Drift System.
Environmental / Meteorological Monitoring System						
Environmental / Meteorological Monitoring	Entire	Non-SC	N/A	N/A	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence. No seismic design criteria identified.
Fire Protection System						
Fire Protection	Entire Subsystems include: Fire Water; Fire Barrier; Explosion Protection; Fire Suppression; Fire Detection; and Fire Alarm	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Fuel Handling Facility						
FHF	Structure	SC	ITS	DBGM-2	No Structural Collapse	Collapse of structure due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
FHF	Rails for Trolleys and WP Transporter	SC	ITS	DBGM-2	No Derailment	Damage to rails and subsequent tipover or slap down of a waste transport due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers.
FHF	Permanent Shielding (including Shield Doors and Walls, Airlock Doors, Shield View Ports, and Viewing Windows)	SC	ITS	DBGM-1	Shielding Integrity Remains Intact	Loss of shielding due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Heating, Ventilation, and Air Conditioning Plant Heating and Cooling System						
HVAC Plant Heating and Cooling	Entire Subsystems include: Hot Water Heating and Chilled Water Cooling	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Low-Level Radioactive Waste Management System						
LLW Management System	Entire Subsystems include: Liquid LLW; Solid LLW; Gaseous LLW; and Mixed LLW	Non-SC	N/A	CD	N/A	No HLW waste forms are handled by this system. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Low-Level Radioactive Waste Generating System						
LLW Generating System	Entire	Non-SC	N/A	CD	N/A	No HLW waste forms are handled by this system. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Lower Natural Barrier System						
Unsaturated Zone Below the Repository Horizon and Saturated Zone Below and Down-gradient from the Repository	Entire	SC	ITWI	N/A	N/A	Natural system is not seismically designed.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function [a,c]**	**Safety Category [a]**	**ITS/ITWI [a]**	**Seismic Category [b]**	**Safety Function (for DBGM Assignment) [d]**	**Basis for Seismic Classification/Comments**
Naval Spent Nuclear Fuel Canister						
NSNF Canister Internals	Internal Geometry Control NSNF Canister Baskets, Loading Sleeves and Cans.	SC	ITWI*	DBGM-2	No Criticality	The SSC shall ensure that as a result of a seismic event, a nuclear criticality cannot occur. Internal geometry controls prevent in-package criticality for preclosure period. *Classification of SSC requires review.
NSNF Canister Internals	Control Rods or Neutron Absorbing Material and Their Attachment Hardware and SNF Cladding	SC	ITWI	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
NSNF Canister	NSNF Canister	SC	ITS/ITWI	DBGM-2	No Breach	Breach of canister due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Naval Spent Nuclear Fuel Waste Package System						
NSNF WP	WP	SC	ITS/ ITWI	DBGM-2	No Breach No Criticality	Breach of canister due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). The SSC shall ensure that as a result of a seismic event, a nuclear criticality cannot occur.
NSNF WP	Trunnion Collar	SC	ITS	DBGM-2	No Drop	Breach of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Non-Nuclear Handling System						
Non-Nuclear Handling	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Non-Radiological Waste Management System						
Non-Radiological Waste Management	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Plant Services System						
Water Distribution	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Fuel Oil Distribution	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function [a,c]**	**Safety Category [a]**	**ITS/ITWI [a]**	**Seismic Category [b]**	**Safety Function (for DBGM Assignment) [d]**	**Basis for Seismic Classification/Comments**
Compressed Air Distribution	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Service Gases Distribution	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Post-Emplacement Subsystem						
Post-emplacement	Thermal Management	Non-SC	N/A	N/A	N/A	System is not seismically designed.
Post-emplacement	Decommis-sioning and Decontamina-tion	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Post-emplacement	Closure (includes Keyways and Backfill in Access Mains and Exhaust Mains; Ventilation Shafts and Raises, and Borehole Seals)	SC	ITWI	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Post-emplacement	Performance Confirmation	Non-SC	N/A	N/A	N/A	System is not seismically designed.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Radiation/Radiological Monitoring System						
Radiation / Radiological Monitoring	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Remediation System						
Dry Remediation	Trolleys	SC	ITS	DBGM-2	No Slap Down	Slap down of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Dry Remediation	Pedestal, and Hold-Down Devices	SC	ITS	DBGM-2	No Tipover	Tipover of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Dry Remediation	Turntable	SC	ITS	DBGM-2	No Tipover	Tipover of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Dry Remediation	Docking Station	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Wet Remediation	200 ton Cask Handling Crane	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Wet Remediation	Pit Crush Pad	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Wet Remediation	Pool Crush Pad	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Wet Remediation	Turntable	Non-SC	N/A	CD	N/A	This turntable has no rails and does not hold a trolley. No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Wet Remediation	Fuel Handling Machine and Grapples	SC	ITS	DBGM-1	Maintain Waste Form	Drop of waste form could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Wet Remediation	Fuel Handling Machine and Grapples	SC	ITS	DBGM-2	No Fall Down	Fall of this SSC onto WP containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
Wet Remediation	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	Drop due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Wet Remediation	Staging Racks in Remediation Pool	SC	ITS	DBGM-2	No Release No Criticality	Collapse/failure of these SSCs containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
WP Remediation	100 ton WP Remediation Crane (DTF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Remediation	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	Drop due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
WP Remediation	WP/DPC Trolleys	SC	ITS	DBGM-2	No Slap Down	Slap down of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Remediation	Pedestals, and Hold-Down Devices	SC	ITS	DBGM-2	No Tipover	Tipover of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Safeguards and Security System						
Safeguards and Security	Entire	N/A	N/A	N/A	N/A	System is not seismically designed.
Spent Nuclear Fuel Aging System						
Cask Transfer	Cask Tractor	SC	ITS	DBGM-2	No Runaway	Slap down of cask without impact limiters due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
Cask Transfer	Horizontal Storage Module Cart	SC	ITS	DBGM-2	No Slap Down No Runaway	Slap down of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). [e]
Cask Transfer	MSC Transporter	SC	ITS	DBGM-2	No Slap Down No Runaway	Slap down of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2). [e]
Aging Pad	Surface Aging Pad	SC	ITS	DBGM-2	No Significant Cracking / Displacement	Tipover of cask by uneven base pad due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Aging Pad	Support Structures (Including Utility Buildings and Personnel Barriers)	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Aging Pad	Aircraft Protection Barrier that Surrounds the Aging Pads	SC	ITS	CD	N/A	Barrier also provides shielding to workers outside GROA along adjacent road to North Construction Portal. As workers can readily exit this area, dose from failure of SSC is not identified to exceed the performance objectives of 10 CFR 63.111(b)(1) due to a seismic event.
Aging Cask / MSC	MSCs and Other Vertical Aging / Staging Systems*	SC	ITS	DBGM-2	No Tipover No Breach	Tipover of, or release from the MSC due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. *Further breakout of BSC (2004r, Appendix A).
Aging Cask / MSC	Horizontal Aging Modules (HAMs)]*	SC	ITS	DBGM-2	No Collapse [Potential for Seismic Interaction]	Collapse of the HAM on a cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister. Potential for displacement of HAM and impacting contained cask shall be examined during design as potential for seismic interaction. *Further breakout of BSC (2004r, Appendix A).
Spent Nuclear Fuel / High Level Waste Transfer System						
WP Loadout	100 ton WP Handling Crane (DTF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
WP Loadout	100 ton WP Loadout Handling Crane (DTF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	Drop due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	Trolleys	SC	ITS	DBGM-2	No Slap Down	Slap down of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	Pedestal, and Hold-Down Devices	SC	ITS	DBGM-2	No Tipover	Slap down of cask due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	WP Tilting Machine	SC	ITS	DBGM-2	No Drop No Slap Down	Slap down or drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	WP Turntable	SC	ITS	DBGM-2	No Tipover	Tipover of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
WP Loadout	Trunnion Collar Removal Machine	SC	ITS	DBGM-2	No Slap Down No Breach	Trunnion collar removal machine can potentially cause slap down of WP after impact, or breach WP during removal process. SSC could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function [a,c]**	**Safety Category [a]**	**ITS/ITWI [a]**	**Seismic Category [b]**	**Safety Function (for DBGM Assignment) [d]**	**Basis for Seismic Classification/Comments**
DPC Cutting	Cutting Machine (DTF)	SC	ITS	DBGM-2	No Failure No Fall Down [Potential for Seismic Interaction]	Potential interaction from miscut of dual-purpose canister due to a seismic event. Machine could potentially fall into open WP.
DPC Cutting	DPC Docking Station	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Dry Transfer	Spent Fuel Transfer Machine and Grapples (DTF and FHF)	SC	ITS	DBGM-1	Maintain Waste Form	Mishandling of fuel due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1) .
Dry Transfer	Spent Fuel Transfer Machine and Grapples (DTF and FHF)	SC	ITS	DBGM-2	No Fall Down	Collapse/failure of this SSC onto a open WP could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
Dry Transfer	70 ton Canister Handling Crane (DTF)	SC	ITS	DBGM-2	No Drop	Drop of WP due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.
Dry Transfer	70 ton Navy Canister Handling Crane (DTF)	SC	ITS	DBGM-2	No Drop	Assignment to DBGM-2 per Assumption 5.20.
Dry Transfer	Crane Lifting Yokes	SC	ITS	DBGM-2	No Drop	Drop due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by release from a DSNF canister.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Dry Transfer	Cask/WP Docking Station	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Dry Transfer	Canister and SNF Staging Racks (DTF)	SC	N/A	DBGM-2	No Release	Collapse/failure of this SSC containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
Dry Transfer	Canister and SNF Staging Racks (DTF)	SC	N/A	DBGM-2	No Criticality	Collapse/failure of this SSC containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2).
Dry Transfer	Staging Pits (CHF)	SC	ITS	DBGM-2	No Release	Collapse/failure of these SSCs containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
Dry Transfer	Staging Pits (CHF)	SC	ITS	DBGM-2	No Criticality	Collapse/failure of these SSCs containing canisters could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of a DSNF canister.
Subsurface Development						
Subsurface Development	Excavation	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Subsurface Facility						
Subsurface Facility	Rails	Non-SC	N/A	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Subsurface Facility	Size and Layout of Drifts	SC	ITS / ITWI	CD	N/A	No function of this facility is credited for the prevention or mitigation of a seismically-initiated event sequence. Low extraction ratio of underground facility precludes total collapse of tunnel system under DBGM-2 loading.
Subsurface Facility	Non-emplacement Openings	SC	ITS	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Subsurface Facility	Ground Support for Non-emplacement Openings	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Subsurface Ventilation System						
Subsurface Ventilation	Entire (Emplacement Ventilation, including Access Main)	Non-SC	N/A	CD	N/A	No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.
Surface Industrial Heating Ventilation Air Conditioning						
Surface Industrial HVAC	Inlet and Outlet Dampers and Ventilation Ducting for Fuel Element Staging Areas (DTF Only)	SC	ITS	DBGM-1	No Failure	Failure of dampers and ducting required for passive airflow due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Surface Industrial HVAC	Stack for Fuel Element Staging Areas (DTF Only)	SC	ITS	DBGM-1	Controlled Failure [Potential for Seismic Interaction]	The failure of the stack due to a seismic event shall not obstruct an open flow path to the environment for all Category 1 seismically-initiated event sequences. Failure of passive airflow due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1).
Surface Industrial HVAC	SSCs Other Than Inlet and Outlet Dampers and Ventilation Ducting (including stack) for Fuel Element Staging Areas (DTF Only)	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Surface Nuclear Heating Ventilation Air Conditioning						
Primary	Exhaust Fans, High-Efficiency Particulate Air (HEPA) Filters, Inlet Isolation Dampers, Exhaust Isolation Dampers, Inlet and Exhaust Ducting for Waste Transfer Cells (DTF and FHF Only)	SC	ITS	CD (Except As Specifically Identified)	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Primary	HEPA Filters	SC*	ITS*	DBGM-1	No Discharge	Filters will (with time) accumulate radioactive particulates, which may be released to workers after a seismic event and failure of a HEPA unit. Dose is unspecified at this time, but potentially could exceed 15 mrem. Therefore, release of contents due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1). *Based on classification of Primary subsystem.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Primary	Vent Ducts (Exhaust Ducting and Dampers)	SC*	ITS*	DBGM-1	No Discharge	Ducts will (with time) accumulate radioactive particulates, which may be released to workers after seismic event and failure of vent ducts. Dose is unspecified at this time, but potentially could exceed 15 mrem. Therefore, release of contents due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(1). *Based on classification of Primary subsystem.
Secondary	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Tertiary	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Transportation Cask						
Transportation Cask	Entire	SC	ITS	DBGM-2	No Breach No Criticality	Transportation casks received at the geologic repository operations area operations area shall be designed and licensed in accordance with 10 CFR Part 71. Design loads in compliance with 10 CFR Part 71 bound the expected seismic loads for seismically-initiated sequences with transporters with impact limiters. The SSC shall ensure that as a result of a seismic event, a nuclear criticality cannot occur.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Transportation Cask Receipt/Return Facility						
Cask Receipt and Return Area	Structure	SC	ITS	DBGM-2	No Structural Collapse	Collapse of structure due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers. Seismic evaluations shall consider potential collapse of adjacent Warehouse and Non-Nuclear Receipt Facility.
Transportation Cask Buffer Area	Structure	Non-SC	N/A	CD	N/A	Facility is unenclosed and no overhead structural component is identified for structure. Transportation casks stored in buffer area shall have impact limiters attached. Design loads in compliance with 10 CFR Part 71 bound the expected seismic loads for seismically-initiated sequences with transporters with impact limiters in this area. Therefore, no function of this SSC is credited for the prevention or mitigation of a credible seismically-initiated event sequence.
Upper Natural Barrier System						
Topography and Surficial Soils and Unsaturated Zone to the Repository Horizon	---	SC	ITWI	N/A	N/A	Natural system is not seismically designed.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	Subsystem/ Component/ Function [a,c]	Safety Category [a]	ITS/ITWI [a]	Seismic Category [b]	Safety Function (for DBGM Assignment) [d]	Basis for Seismic Classification/Comments
Warehouse and Non-Nuclear Receipt Facility						
Warehouse and Non-Nuclear Receipt Facility	Structure	Non-SC	N/A	CD	N/A [Potential Seismic interaction]	Structure shares a wall and subsystems with the Transportation Cask Receipt/Return Facility, and may interact with this ITS Facility. Design review required to demonstrate no seismic interaction, or SSCs that will prevent this interaction.
Waste Package Closure System						
Welding (Equipment)	Entire	Non-SC*	N/A	DBGM-2	No Fall Down [Potential Seismic interaction]	Fall (loss of anchorage) of this SSC into a waste package due to a seismic event could initiate an event sequence exceeding the performance objectives of 10 CFR 63.111(b)(2) by breach of DSNF canister or other waste containers. Potential for burn-through identified in Attachment III, but seismically-initiated sequence is considered to be not credible (Assumption 5.6). *Classification of SSC requires review.
Inerting (Equipment)	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Nondestructive Testing (Equipment)	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Stress Mitigation (Equipment)	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
WP Identification	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Spread Ring Installation	Entire	Non-SC	N/A	CD	N/A	No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Material Handling	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.
Remote Equipment Maintenance	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of these SSCs is credited for the prevention or mitigation of a seismically-initiated event sequence.

Table IV-1. Seismic Classification of Systems, Components and Functions (Continued)

System/ Subsystem [a]	**Subsystem/ Component/ Function** [a,c]	**Safety Category** [a]	**ITS/ITWI** [a]	**Seismic Category** [b]	**Safety Function (for DBGM Assignment)** [d]	**Basis for Seismic Classification/Comments**
Operations Control	Entire	Non-SC	N/A	N/A	N/A	No seismic design required for SSC. No function of this SSC is credited for the prevention or mitigation of a seismically-initiated event sequence.

NOTES:

[a] System/Facility list, Safety Category and ITS/ITWI assignments are modified from BSC (2004r, Appendix A); the System/Facility list was further expanded for clarification, as required.

[b] SSCs designated, ”conventional design” (CD), shall be designed in accordance with the methodology of Section 1615 of the International Building Code (ICC 2000), and incorporating all relevant Project seismic criteria and standards, as appropriate (BSC, 2004aa, Section 6.1.3.2; BSC 2004x, Section 6.4).

[c] The term cask refers to both the transportation cask and the site-specific cask, unless specified otherwise.

[d] Safety Functions are defined in Section 4.3.

[e] Operational considerations may limit or prohibit the transport of DSNF to the Aging Pad, but for the conservatism, it is included for this analysis.

AC = alternating current; CD = conventional design; CHF = Canister Handling Facility; DBGM = design basis ground motion; DC = direct current; DOE = U.S. Department of Energy; DSNF = U.S. Department of Energy-owned spent nuclear fuel; DTF = Dry Transfer Facility; DPC = dual purpose canister; FHF = Fuel Handling Facility; HLW = high-level radioactive waste; HVAC = heating, ventilation, and air-conditioning; HEPA = high-efficiency particulate air (filter); ITS = important to safety; ITWI = important to waste isolation; LLW = low-level waste; MSC = monitored geologic repository site-specific cask; N/A = Not Applicable; Non-SC = non-safety category; SC = safety category; SNF = spent nuclear fuel; SRTC = site rail transfer cart; SSC = structure, system, or component; SSCs = structures, systems, and components; TCRRF = Transportation Cask Receipt/Return Facility; UPS = uninterruptible power supply; V = volts; WP = waste package.

ATTACHMENT V
GENERALIZED SEISMIC EVENT TREES

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Table V-1. Seismic Event Tree Event Definitions

Event Name (Failure State)	Event Definition
BR_DROP	Waste Form Breaches After Drop
BR_FALL	Waste Form Breaches After Fall
BR_SLAP	Waste Form Breaches After Slap-down
CELL_COLL	Transfer Cell Structure Collapses
CONF_CELL	Confinement Structure Fails
CONF_CELL_F	Confinement Structure Fails
DR_LOAD	Crane or Fuel Handling Machine Drops Load
DR_LOSP	Waste Form Drops or Collides With Object (Due To Seismic/LOSP Effect On Control System)
EQPT_SUP	Crane or Fuel Handling Machine Structure Fails
EQ	Earthquake Occurs
EQT_FS	Handling Equipment Does Not Stop In Fail-Safe Mode
F_DR_COL	Fire Causes Waste Form To Drop or Collide With Object
FIRE_CELL	Fire Initiated In Cell (Electrical or Other)
GEOM_COOL	Geometry/Ducting Fails
HEPA_CELL	HVAC/HEPA Filtration Fails
HEPA_CELL_F	HVAC/HEPA Filtration in Cell Fails
HEPA_LOSP	HVAC/HEPA Filtration Power Fails
HVAC_COOL	HVAC Cooling System Fails to Function
LOSP	Loss of Offsite Power
OF_TRAN	Waste Form Suspended From Handling Equipment (Occupancy Factor)
OTF_CELL	Falling Structure Impacts Staging Rack or Waste In Process (Target/Occupancy Factor)
OTF_STAG	Waste Present (Occupancy Factor) or Equipment Over Waste (Target Factor)
OTF_TROL	Waste Form Present In Operation (Occupancy Factor)
POOL_LIN	Pool Structure/ Liner Fails
POOL_SUPP	Water Supply and Cooling Fails
RES_COOL_C	Restoration Of Cooling or Remedial Action Fails
RES_COOL_P	Restoration Of Level/ Cooling Fails
SUPP_CELL	Fire-Suppression System Fails
TROL_TO	Trolley, Railcar, Fixture Causes Tipover, Slap Down or Impact

NOTE: HEPA = high-efficiency particulate air; and HVAC = heating, ventilation, and air-conditioning.

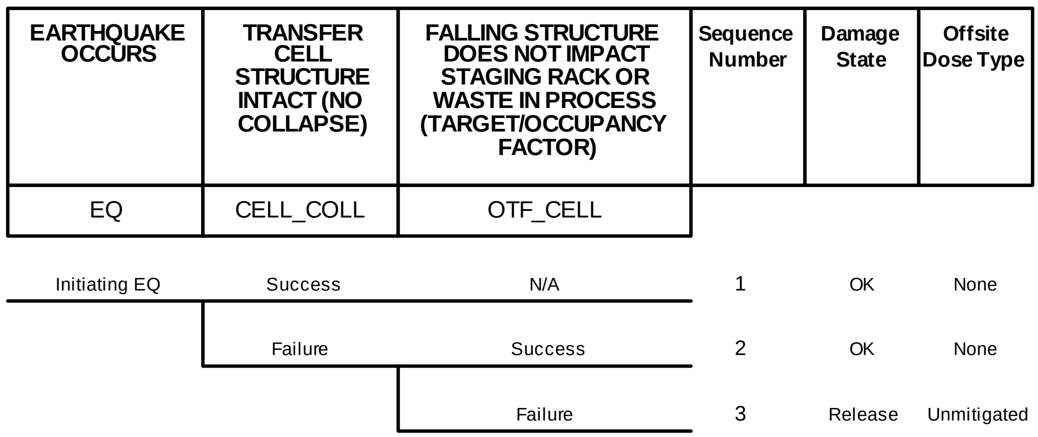

Figure V-1. Seismic Event Tree: Collapse of Structure of Transfer Cell

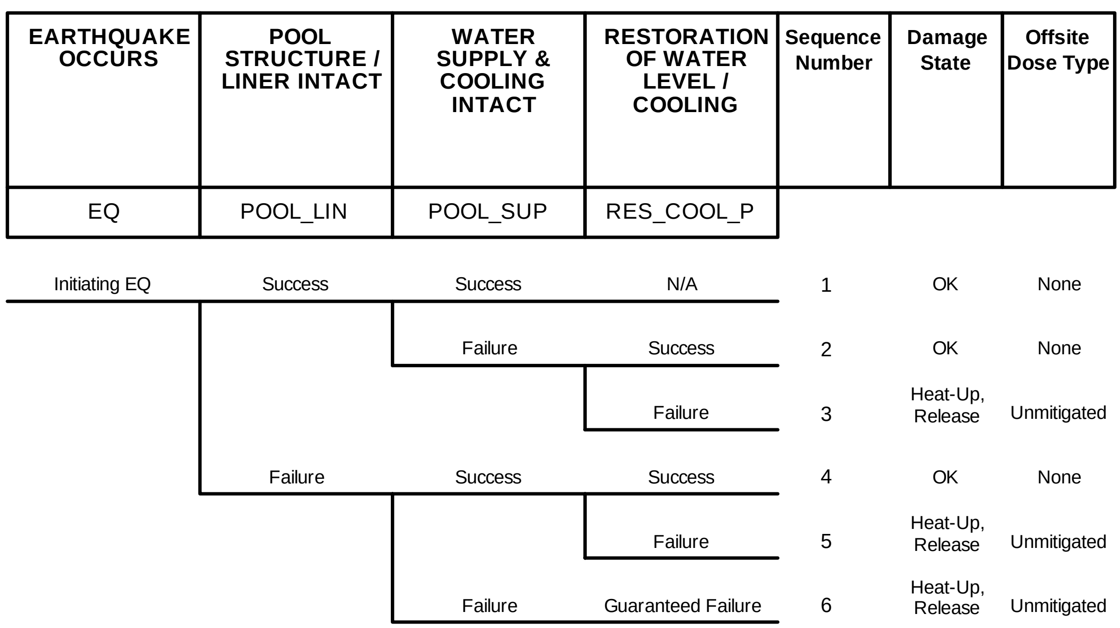

Figure V-2. Seismic Event Tree: Remediation Building Pool Level and Cooling

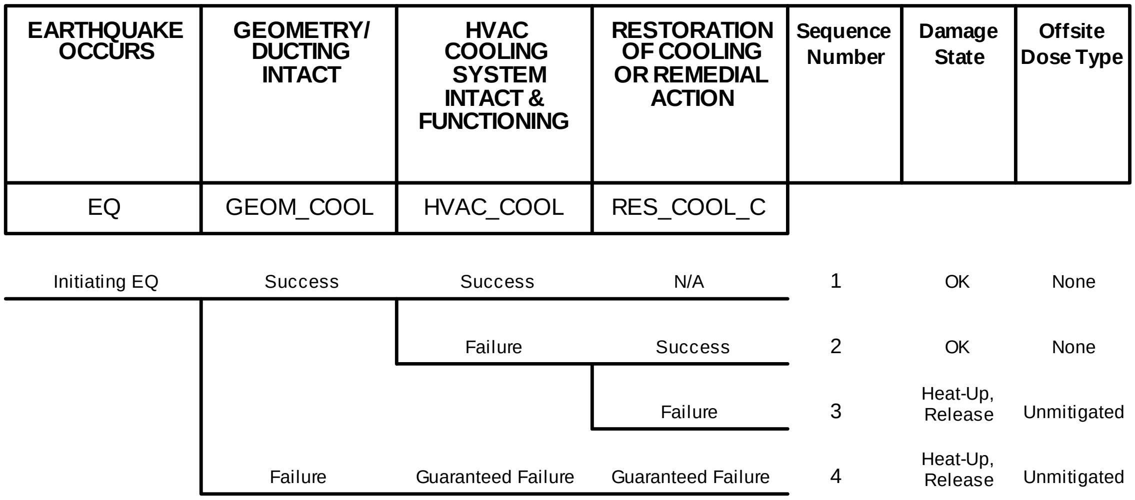

Figure V-3. Seismic Event Tree: Active Cooling of Dry Transfer Facility Staging Commercial Spent Nuclear Fuel

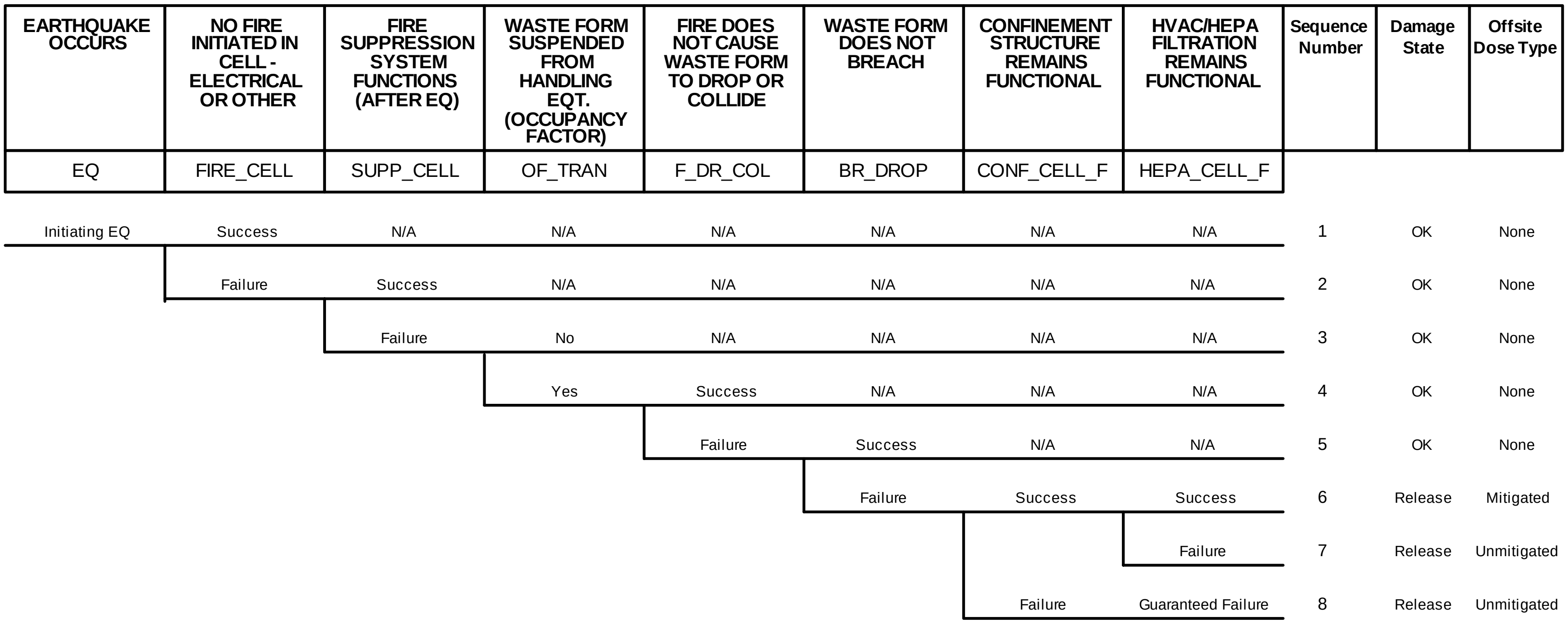

Figure V-4. Seismic Event Tree: Seismically-Induced Fire in Dry Transfer Facility Transfer Cell

EARTHQUAKE OCCURS	OFFSITE POWER AVAILABLE (NO LOSS OF OFFSITE POWER)	HANDLING EQUIPMENT STOPS IN FAILSAFE-MODE	WASTE FORM SUSPENDED FROM HANDLING EQUIPMENT (OCCUPANCY FACTOR)	WASTE FORM DOES NOT DROP OR COLLIDE WITH OBJECT	WASTE FORM DOES NOT BREACH	CONFINEMENT STRUCTURE REMAINS FUNCTIONAL	HVAC/HEPA FILTRATION REMAINS FUNCTIONAL OR RECOVERED	Sequence Number	Damage State	Offsite Dose Type
EQ	LOSP	EQT_FS	OF_TRAN	DR_LOSP	BR_DROP	CONF_CELL	HEPA_LOSP			
Initiating EQ	Success	N/A	N/A	N/A	N/A	N/A	N/A	1	OK	None
	Failure	Success	No	N/A	N/A	N/A	N/A	2	OK	None
			Yes	Success	N/A	N/A	N/A	3	OK	None
				Failure	Success	N/A	N/A	4	OK	None
					Failure	Success	Success	5	Release	Mitigated
							Failure	6	Release	Unmitigated
						Failure	Guaranteed Failure	7	Release	Unmitigated
		Failure	No	N/A	N/A	N/A	N/A	8	OK	None
			Yes	Guaranteed Failure	Success	N/A	N/A	9	OK	None
					Failure	Success	Success	10	Release	Mitigated
							Failure	11	Release	Unmitigated
						Failure	Guaranteed Failure	12	Release	Unmitigated

Figure V-5. Seismic Event Tree: Seismically-Induced Loss of Offsite Power

EARTHQUAKE OCCURS	CRANE OR FUEL HANDLING MACHINE STRUCTURE INTACT	WASTE PRESENT (OCCUPANCY FACTOR) OR EQUIPMENT OVER WASTE (TARGET FACTOR)	WASTE FORM DOES NOT BREACH	CONFINEMENT STRUCTURE REMAINS FUNCTIONAL	HVAC/HEPA FILTRATION REMAINS FUNCTIONAL	Sequence Number	Damage State	Offsite Dose Type
EQ	EQPT_SUP	OTF_STAG	BR_FALL	CONF_CELL	HEPA_CELL			
Initiating EQ	Success	N/A	N/A	N/A	N/A	1	OK	None
	Failure	No	N/A	N/A	N/A	2	OK	None
		Yes	Success	N/A	N/A	3	OK	None
			Failure	Success	Success	4	Release	Mitigated
					Failure	5	Release	Unmitigated
				Failure	Guaranteed Failure	6	Release	Unmitigated

Figure V-6. Seismic Event Tree: Fall of Handling Equipment onto Waste Form

EARTHQUAKE OCCURS	TROLLEY, LORRY, FIXTURE PREVENTS TIPOVER, SLAP DOWN OR IMPACT	WASTE PRESENT IN OPERATION (OCCUPANCY FACTOR)	WASTE FORM DOES NOT BREACH	CONFINEMENT STRUCTURE REMAINS FUNCTIONAL	HVAC/HEPA FILTRATION REMAINS FUNCTIONAL	Sequence Number	Damage State	Offsite Dose Type
EQ	TROL_TO	OTF_TROL	BR_SLAP	CONF_CELL	HEPA_CELL			
Initiating EQ	Success	N/A	N/A	N/A	N/A	1	OK	None
	Failure	No	N/A	N/A	N/A	2	OK	None
		Yes	Success	N/A	N/A	3	OK	None
			Failure	Success	Success	4	OK	None
					Failure	5	Release	Mitigated
				Failure	Guaranteed Failure	6	Release	Unmitigated

Figure V-7. Seismic Event Tree: Tipover/Slap Down in Handling Operations

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ATTACHMENT VI
FAULT TREES

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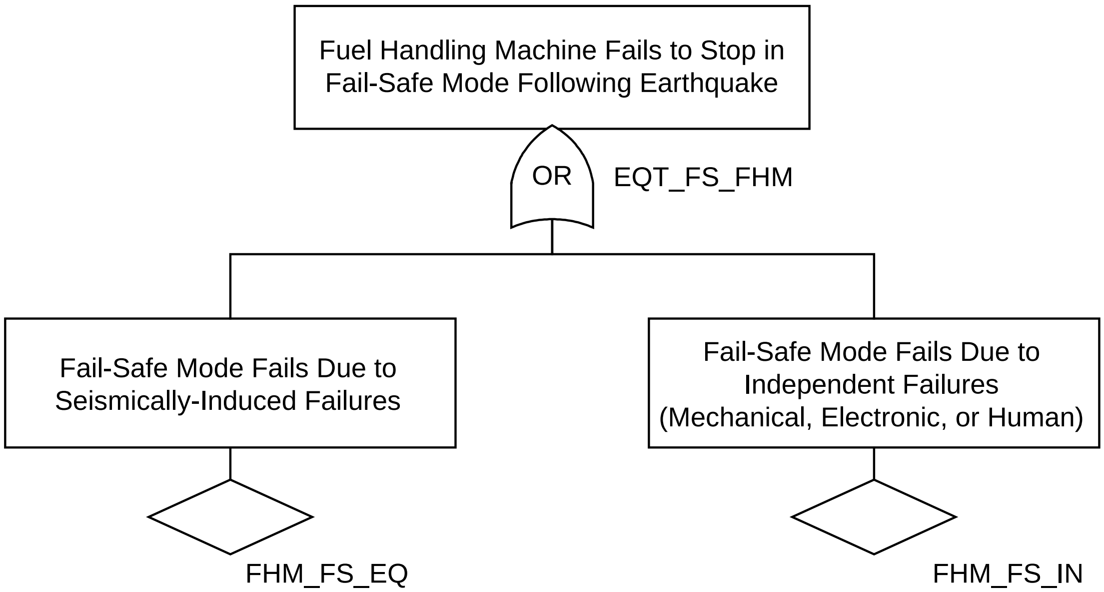
Table VI-1. Fault Tree Top Events

Top Event Name	Description
EQT_FS_FHM	Fuel Handling Machine Fails to Stop in Fail-Safe Mode Following Earthquake
EQT_FS_DTC	DTF Crane Fails to Stop in Fail-Safe Mode Following Earthquake
DR_LOAD_FHM	Fuel Handling Machine Fails to Maintain Suspended Load
DR_LOAD_DTC	DTF Crane Fails to Maintain Suspended Load

NOTE: DTF = Dry Transfer Facility.

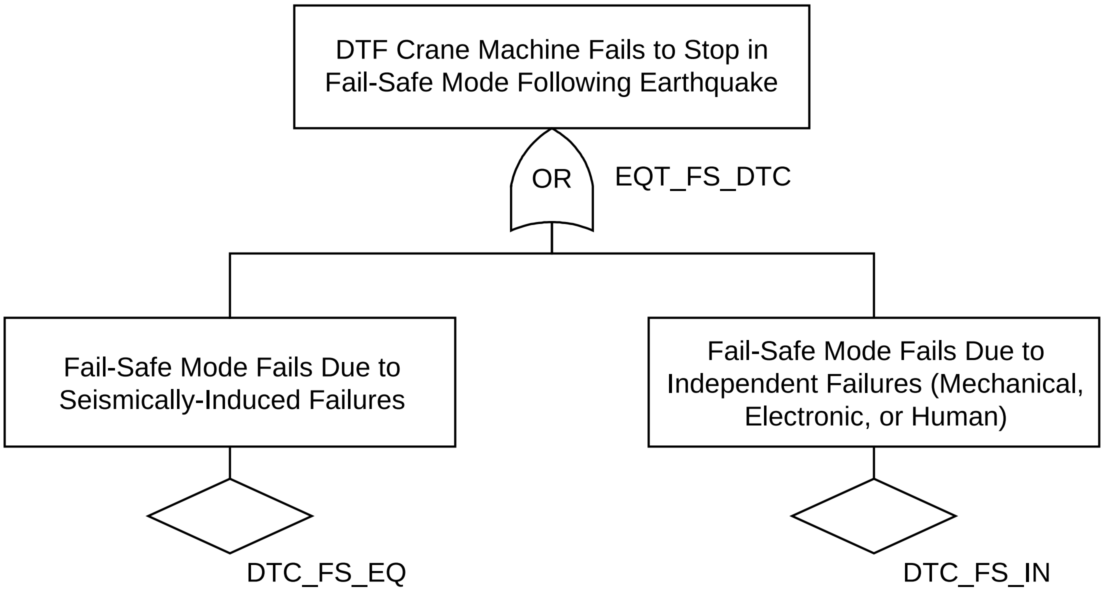
Table VI-2. Basic Event List

Event Name	Description
CONT_LH_EQ	Seismically-induced Failures of Control System
CONT_LH_IN	Independent Failures of Control System
DTC_CONLH_EQ	Seismically-induced Failures of Control System
DTC_CONLH_IN	Independent Failures of Control System
DTC_LH_HFE	Seismically-induced or Influenced Human Failure in using Control System
DTC_FS_EQ	Fail-Safe Mode Fails Due to Seismically-induced Failures
DTC_FS_IN	Fail-Safe Mode Fails Due to Independent Failures (Mechanical, Electronic, or Human)
FHM_FS_EQ	Fail-Safe Mode Fails Due to Seismically-induced Failures
FHM_FS_IN	Fail-Safe Mode Fails Due to Independent Failures (Mechanical, Electronic, or Human)
FHM_LH_EQ	Seismically-induced Failures of Lifting/Holding Mechanisms
FHM_LH_IN	Independent Failures of Lifting/Holding Mechanisms
FHM_CONLH_EQ	Seismically-induced Failures of Control System
FHM_CONLH_IN	Independent Failures of Control System
FHM_LH_HFE	Seismically-induced or Influenced Human Failure in using Control System
TRAN_LH_EQ	Seismically-induced Failures of Lifting/Holding Mechanisms
TRAN_LH_HFE	Seismically-induced or Influenced Human Failure in using Control System
TRAN_LH_IND	Independent Failures of Lifting/Holding Mechanisms



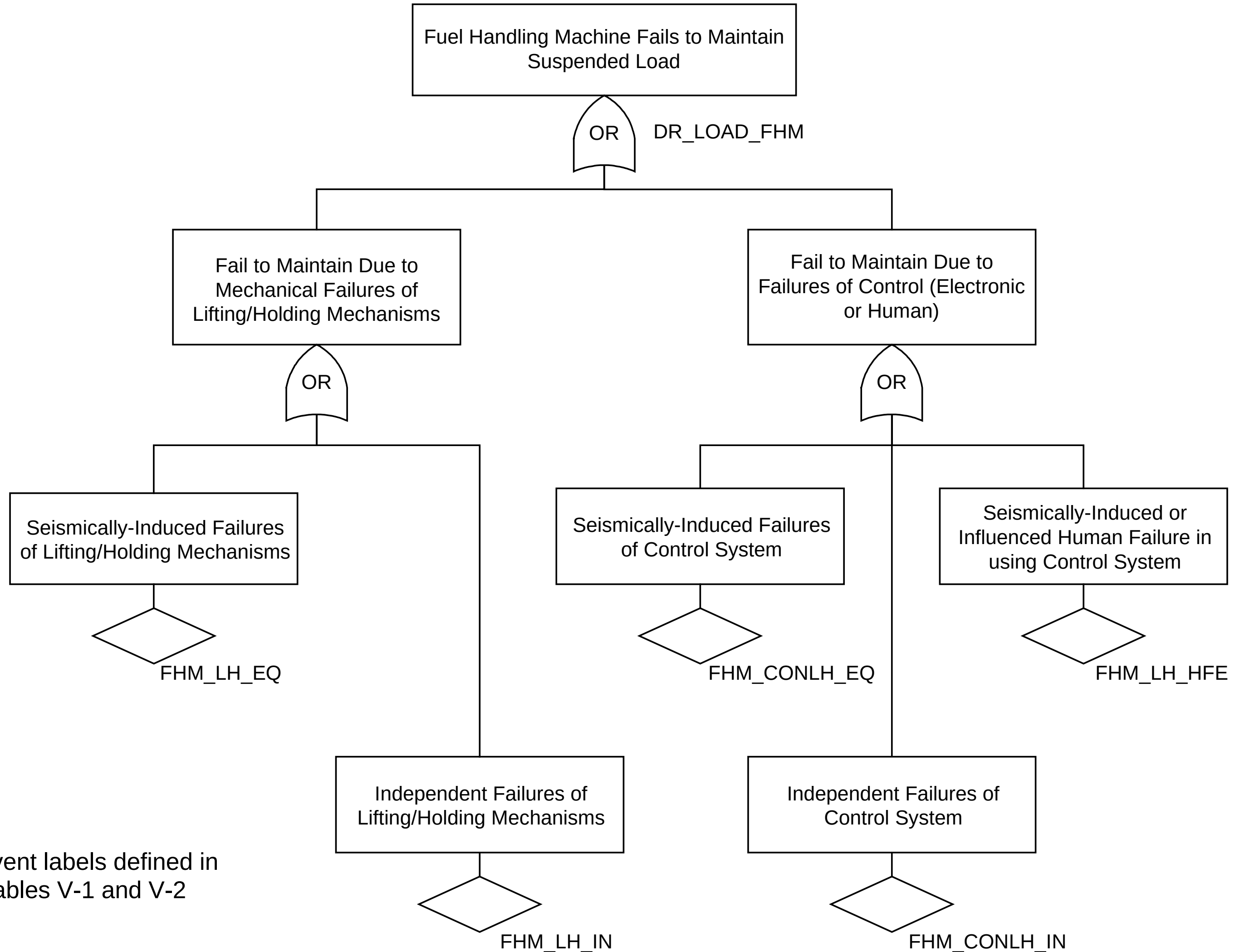
NOTE: Event labels defined in Tables V-1 and V-2

Figure VI-1. Fault Tree: Fuel Handling Machine Fails to Stop in Fail-Safe Mode Following an Earthquake



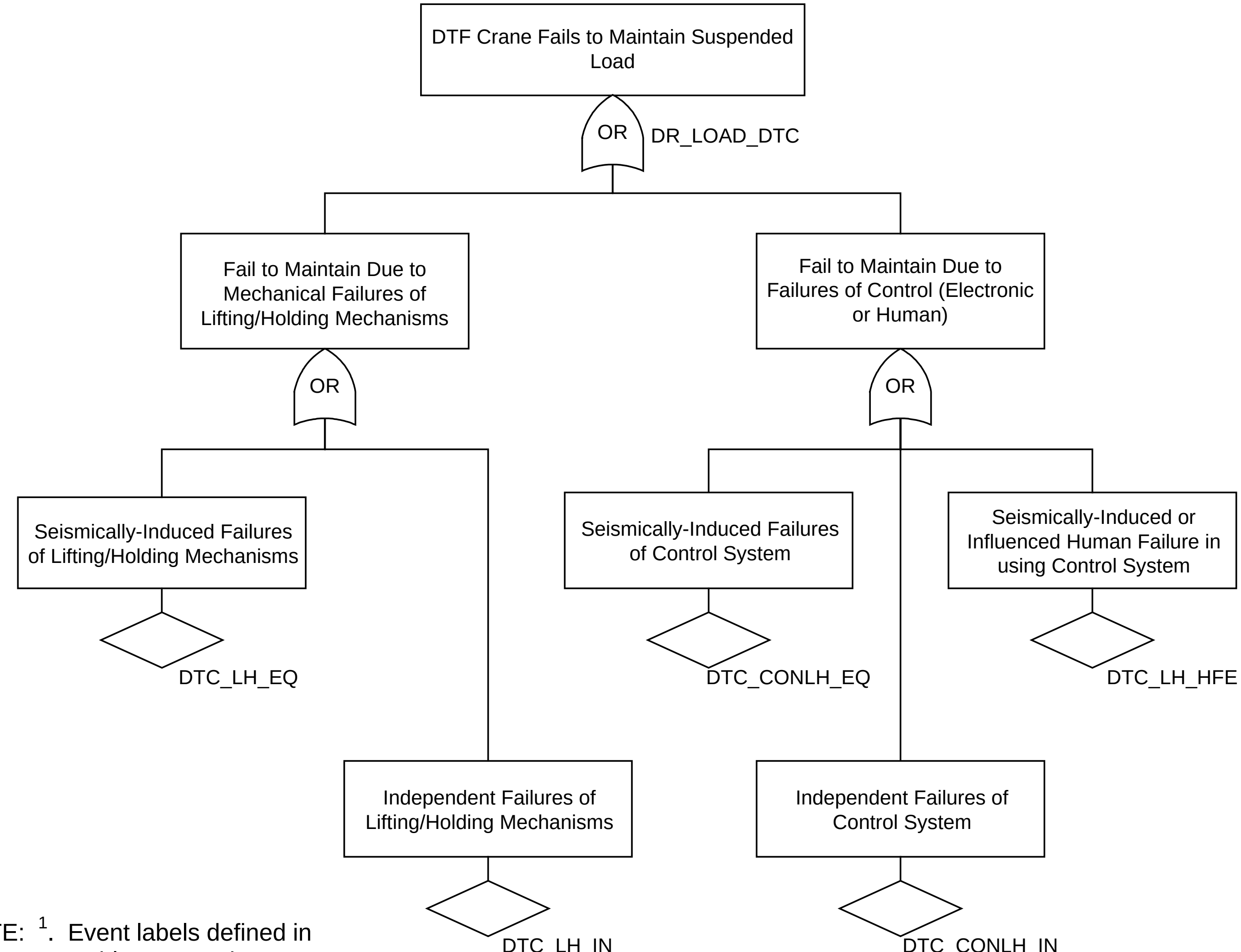
NOTE: Event labels defined in Tables V-1 and V-2

Figure VI-2. Fault Tree: Dry Transfer Facility Crane Fails to Stop in Fail-Safe Mode Following an Earthquake



NOTE: [1]. Event labels defined in Tables V-1 and V-2

Figure VI-3. Fault Tree: Fuel Handling Machine Fails to Maintain Suspended Load



NOTE: [1]. Event labels defined in Tables V-1 and V-2

Figure VI-4. Fault Tree: Dry Transfer Facility Crane Fails to Maintain Suspended Load

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ATTACHMENT VII
SOURCE DATA FOR GROUND MOTIONS ASSOCIATED WITH REFERENCE EARTHQUAKES

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Table VII-1. Source Data for Ground Motions Associated with Reference Earthquakes

Mean Annual Probability of Exceedance	Location	Frequency (Hz)	Period (Seconds)	Horizontal Spectral Acceleration @ 5% Damping (g)	Peak Ground Acceleration (Horizontal) [a] (g)	Average Spectral Accelerations for Rage of Frequencies		DTN/ File Name
						$S_{A(1-2.5)}$ [b] (g)	$S_{A(5-10)}$ [b] (g)	
1.0×10^{-3}	Surface [c]	1.00	1.000	0.2506	0.3709 [f]	0.4332	0.7972	DTN: MO0411SDSDE103.003 File: SPCDAMP10-3_tdms.xls
		2.01	0.498	0.5493				
		2.50	0.400	(0.6158) [d]				
		2.99	0.335	0.6599				
		4.98	0.201	0.7758				
		5.00	0.200	(0.7764) [e]				
		5.99	0.167	0.7957				
		10.00	0.100	0.8180				
		100.00	0.010	0.3709				
1.0×10^{-3}	Emplace-ment Level	1.00	1.000	0.1330	0.1316	0.1713	0.2547	DTN: MO0405SDSTPNTB.001 File:10-3HB1.dat
		2.00	0.500	0.2007				
		2.50	0.400	(0.2096) [g]				
		5.00	0.200	0.2541				
		10.00	0.100	0.2553				
		100.00	0.010	0.1316				

Table VII-1. Source Data for Ground Motions Associated with Reference Earthquakes (Continued)

Mean Annual Probability of Exceedance	Location	Frequency (Hz)	Period (Seconds)	Horizontal Spectral Acceleration @ 5% Damping (g)	Peak Ground Acceleration (Horizontal)[a] (g)	Average Spectral Accelerations for Range of Frequencies		DTN/ File Name
						$S_{A(1-2.5)}$[b] (g)	$S_{A(5-10)}$[b] (g)	
5.0×10^{-4}	Surface[d]	1.00	1.000	0.3918		0.6724	1.2150	DTN: MO0411SDSTMHIS.006 File: spcdamp5E-4_TDMS.xls
		2.01	0.498	0.8309				
		2.50	0.400	(0.9531)[d]				
		2.99	0.335	1.0341				
		4.98	0.201	1.1779				
		5.00	0.200	(1.1789)[e]				
		5.99	0.167	1.2106				
		10.00	0.100	1.2512				
		100.00	0.010	0.5802	0.5802[f]			
5.0×10^{-4}	Emplace-ment Level	1.00	1.000	0.1880		0.2383	0.3678	DTN: MO0407SDARS104.001 File:5e-4Horizontal Spectrum.dat
		2.00	0.500	0.2749				
		2.50	0.400	(0.2885)[g]				
		5.00	0.200	0.3567				
		10.00	0.100	0.3789				
		100.00	0.010	0.1911	0.1911			

Table VII-1. Source Data for Ground Motions Associated with Reference Earthquakes (Continued)

Mean Annual Probability of Exceedance	Location	Frequency (Hz)	Period (Seconds)	Horizontal Spectral Acceleration @ 5% Damping (g)	Peak Ground Acceleration (Horizontal) [a] (g)	Average Spectral Accelerations for Range of Frequencies		DTN/ File Name
						$S_{A(1-2.5)}$ [b] (g)	$S_{A(5-10)}$ [b] (g)	
1.0×10^{-4}	Surface [d]	1.00	1.000	1.0704		1.5827		DTN: MO0411WHBDE104.003 File: Spcdamp10-4_TDMS.xls
		2.01	0.498	1.9482				
		2.50	0.400	(2.0950) [d]				
		2.99	0.335	2.1924				
		4.98	0.201	2.4746			2.5151	
		5.00	0.200	(2.4753) [e]				
		5.99	0.167	2.4490				
		10.00	0.10	2.5548				
		100.00	0.01	1.1926	1.1926 [f]			
1.0×10^{-4}	Emplace-ment Level	1.00	1.000	0.4197		0.5475		DTN: MO0306SDSAVDTH.000 File:10-4BH.dat
		2.01	0.498	0.6139				
		2.48	0.404	0.6726				
		2.50	0.400	(0.6753) [h]				
		2.54	0.394	0.6794				
		4.98	0.201	0.8187			0.8273	
		5.00	0.200	(0.8192) [i]				
		5.09	0.196	0.8211				
		10.00	0.100	0.8355				
		100.00	0.010	0.4257	0.4257			

NOTES:

[a] PGA values are calculated at a frequency of 100 Hz (period = 0.01 second) at 5% damping.

[b] $S_{A(1\text{-}2.5)} = [(SA_1 + SA_{2.5}) / 2]$ and $S_{A(5\text{-}10)} = [(SA_5 + SA_{10}) / 2]$, where SA_1, $SA_{2.5}$, SA_5, and SA_{10} are the maximum horizontal spectral accelerations at 1 Hz, 2.5 Hz, 5 Hz, and 10 Hz, respectively, for 5% damping.

[c] Surface values were defined for the “Waste Handling Building Area” (BSC 2002, Figure 1) based on profiles for 35 ft (11 m) and 110 ft (34 m) of alluvium (soil).

[d] The value for a frequency of 2.5 Hz for subsurface facilities is not explicitly shown in the data source. The value was computed using a simple linear scaling of the values at 2.01 Hz and 2.99 Hz.

[e] The value for a frequency of 5.0 Hz for subsurface facilities is not explicitly shown in the data source. The value was computed using a simple linear scaling of the values at 4.98 Hz and 5.99 Hz.

[f] PGA values for surface facilities are computed at Point D/E. Location of computation points for surface facilities and emplacement level is shown in BSC (2004v, Figure 1).

[g] The value for a frequency of 2.5 Hz for subsurface facilities is not explicitly shown in the data source. The value was computed using a simple linear scaling of the values at 2.0 Hz and 5.0 Hz.

[h] The value for a frequency of 2.5 Hz for subsurface facilities is not explicitly shown in the data source. The value was computed using a simple linear scaling of the values at 2.48 Hz and 2.54 Hz.

[i] The value for a frequency of 5.0 Hz for subsurface facilities is not explicitly shown in the data source. The value was computed using a simple linear scaling of the values at 4.98 Hz and 5.09 Hz.

BDBGM = beyond design basis ground motion; DBGM = design basis ground motion; DTN = document tracking number; g = acceleration due to gravity; SA = spectral acceleration; $S_{A(X\text{-}Y)}$ = average spectral acceleration for a range, computed as the average of spectral accelerations at frequency “X” and frequency “Y”.